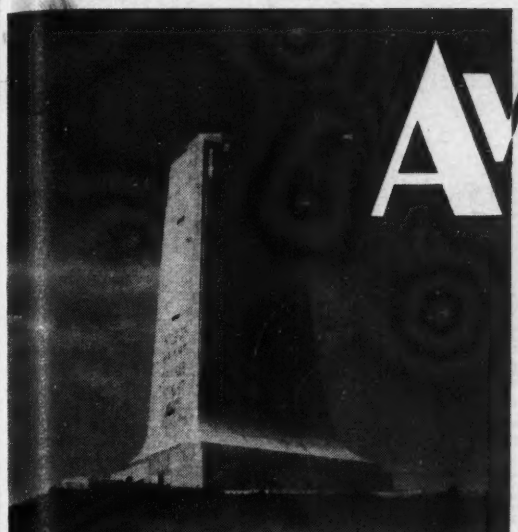

AVIATION

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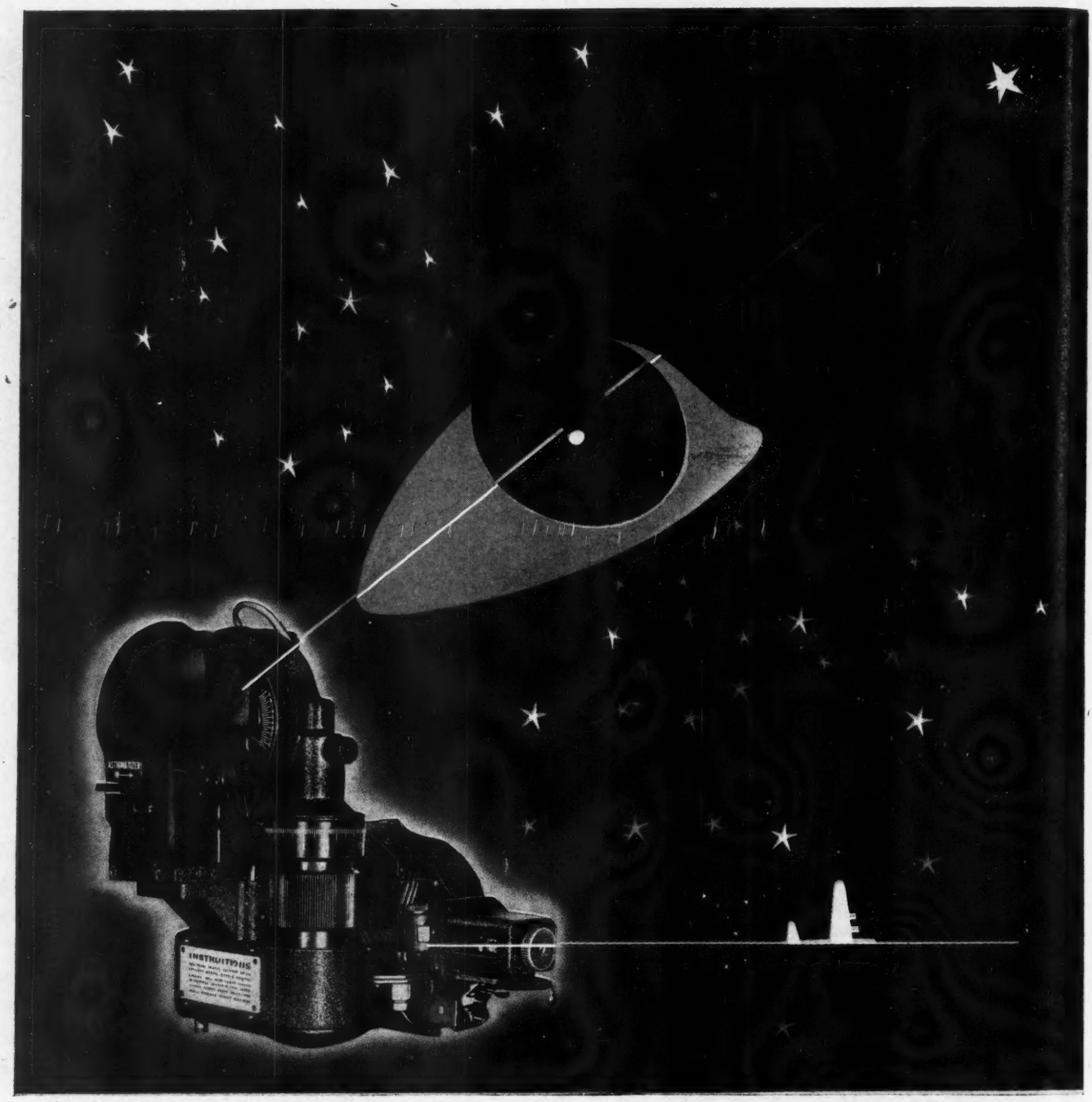

WHEN MINUTES MEAN MILES

Accurate navigation of fast-flying aircraft calls for a finely designed and constructed sextant. To assist the navigator in obtaining an on-the-nose "fix," the optical precision of this new Pioneer Aircraft Sextant is supplemented by a built-in, chronometric averaging device. This mechanism automatically computes 1/60 the angular height of a sighted star, or other heavenly body, every two seconds for a two-minute period, and records the average of the 60 readings on a counter. The Pioneer self-averaging sextant is a notable contribution to the science of navigation...typical of Pioneer advanced design and precision manufacture. Eclipse-Pioneer Division, Teterboro, N. J.

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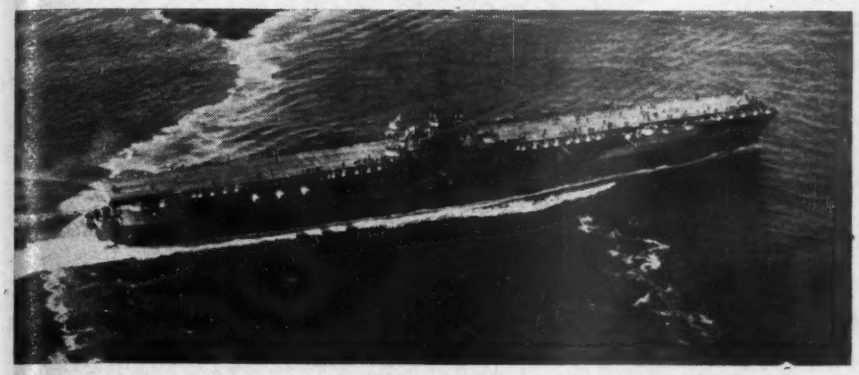
Briefing for June



Carrier-based aviation, once loudly berated by self-styled "experts," has emerged as a new weapon, one which has changed both strategic and tactical concepts of warfare. How this new, typically American weapon evolved and how it is being used is told dramatically by Rear Adm. DeWitt C. Ramsey, Chief of the Navy's Bureau of Aeronautics, in "America's Prime Weapon," beginning on page 110. (Official U. S. Navy photo.)

When the aircraft manufacturing industry—long famed for its internecine warfare—really got down to unparalleled cooperation in war production, many old timers thought they had seen a miracle. Now, however, they can truthfully say they've seen everything—for today the industry is working to continue that cooperation into the peace. Through the revitalized Aero Chamber of Commerce, the industry has written a recommendation for an American Air Power Policy, a truly important document. For "the record," we present it in its entirety (page 108).

Many and varied have been the predictions on the airplane's place in the coming peacetime economy. Few, however, have been presented by aeronautical engineers who know whereof they speak. Beginning on page 120, we inaugurate a thoroughgoing series by Frederic Flader, offering for the first time an "economy yardstick" applicable not only to currently-used conventional engine-propeller units but also to jet-propelled and propeller-jet combinations.

One of the best word pictures we've seen of the inside of a blind-flying pilot's head starts the article by Jean Hamelet, Convair flight captain. But, fortunately, he doesn't stop there; he comes up with a good flying man's plea not only for rearrangement of blind flying instruments but also re-design. This intriguing story begins on page 138.

So you'd like to open a fly-yourself service? Well, it'll "cost more than a quarter and take a lot of faith" says Howard Ailor. And he ought to know, for he operated the nation's biggest such service before the war. You'll find the cold facts, written from his own experience, in "Fly Yourself is Big Business" (page 185).

Constantly increasing sizes of aircraft make the automatic pilot more and more important, both to the designer and the maintenance man. On page 140, Dr. Stephen J. Zand, director of Sperry's Vose Memorial Laboratory, gives a timely description of automatic flight principles which will fill a much-felt need for technical reference work in this ever more-important field.

As aircraft uses of cellulose acetate plastics broaden, designers and engineers find themselves in greater need for facts and figures on the load resisting qualities of these materials. To answer that need we start this month (on page 146) an exhaustive analysis by William T. Findley, asst. prof. of Theoretical and Applied Mechanics at the University of Illinois College of Engineering.

Again there's plenty of material for the maintenance man. First (on page 161) T. J. Kearney, technical assistant to the vice president, Dextrex Corp., details a new and efficient system for getting aircraft parts cleaned up preparatory to overhaul . . . Then, in "Zero-Lash" (page 165) will be found clear, concise procedures for adjusting push rods on the widely used Franklin Aircooled engine . . . On page 167 begins a profusely illustrated step-by-step account of recommended methods for inspecting, cleaning, and adjusting shielded sparkplugs . . . For those operators who want to cut engine overhaul time—and who doesn't?—J. R. Horton, vice president of Embry-Riddle Co., describes time-savers which have increased capacity of the overhaul shop . . . and in addition, there's a complete description of the parts—and their functions—in the MA-3A Marvel-Schebler carburetor, plus procedures for both hot and cold starting. And, with apologies to the movies, all this and the Maintenance Notebook, too.

And—continued from last month: Second and concluding installment of Detroit Editor Chester S. Ricker's superb "Design Analysis of the deHavilland "Mosquito", beginning on page 123 . . . Associate Editor John Foster's outstanding manufacturer-distributor market analysis (page 114), which in this installment covers the middle of the country, giving data on the East and North Central and East and West South Central Regions . . . Also Part II of "Methods for Forming Sheet Aluminum" where the reader will find a graphic description of standardized shop procedure followed in the spinning branch of the industry.

Down the Years in AVIATION'S Log

25 Yrs. Ago (1919)—Naval airship C-5 cruises 1,100 mi. nonstop under adverse weather conditions but is wrecked at moorings . . . N. Y.-Washington airmail shows $19,000 profit for year . . . Assistant Sec'y of War Benedict Crowell sails for Europe with Air Commission to study civil aviation . . . Unlicensed aviator pilots flying boat over heads of crowd at Fifth Avenue military parade . . .

15 Yrs. Ago (1929)—Robbins and Kelly establish refueling endurance flight record of 172 hr. 32 min. at Ft. Worth . . . Lt. W. C. Tomlinson wins Curtiss Marine Trophy race flying *Hawk* 100 mi. at 173 mph. . . . D. of C. Aeronautics Branch appoints flying school inspectors . . . Pitcairn-Cierva builds $100,000 autogiro factory . . . Indianapolis "flying cop" forces down and arrests pilot whose plane endangered balloon . . . Junkers *Bremen* presented to New York City and exhibited in Grand Central Station . . . Aerial mapping firm organized in Portland, Ore. . . .American Glider Assn. organized in Los Angeles . . . Fairchild says employees have risen from 9 to 800 in three years . . . Florida has 20 airports in operation . . . Goodyear-Zeppelin announces training course for pilots for projected trans-Pacific air route . . . Night airmail started between Pittsburgh and Cleveland . . . Bolivia Gold Exploration Co. swaps gold ingots for Travel Air planes . . .

10 Yrs. Ago (1934)—Pan American opens International Air Terminal at Dinner Key, Fla. . . . Chinese build world's first floating hangar. . . . Air Corps announces exhaust-turbine-supercharged Curtiss P-30.

THE KOLLSMAN VERTICAL SPEED INDICATOR is so sensitive that a pressure differential of but one millimeter of water causes the instrument to register 100 feet on the dial. This is comparable to the difference in pressure between the inside and outside of a soap bubble. Friction is reduced almost to the vanishing point by ingenuity of design and precision manufacture. But despite its delicacy, the instrument is compact, light in weight, rugged, dependable . . . characteristic of all Kollsman aircraft instruments.

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A Unified Industry Writes Its Magna Charta

THE recent Los Angeles meeting of the Governors of the Aeronautical Chamber of Commerce of America, was a milestone in the history of aviation in America. Never before has there existed such unanimity in the industry. The Board of Governors of the Chamber is now composed of the presidents of the companies responsible for by far the major part of this country's aeronautic output. This represents 36 percent of America's war production. Thus, action of the Board can importantly affect our whole domestic economy.

Assembled in that great center of airframe production, these men devoted two full days to meetings of the joint Aircraft War Production Councils (concentrating on cooperation in the war effort) and one day in reorganizing the Chamber as an association for long-term planning and delineation of industry policy. Since sound policy is the first requirement of any plan, and since aviation is predominantly a public rather than a private instrument, the Governors unanimously recommended the early formulation under certain guiding principles of a national aviation policy.

Perhaps the most significant aspect was the broad ground on which the group approached the problem. It defined air power as a four-pronged implement, composed of air *forces,* air *bases,* air *transport* and aircraft *manufacture*—a real step forward from the usual connotation of "air power" in the narrower sense of an air striking force. It recognizes the coming of age of air power and forecasts its profound influence on history. Perhaps the best summation of the board's action was this headline in a Los Angeles morning paper: "Air Chiefs Vote Sky Mastery as Peace Guarantee."

HERE WE HAVE a significant action. A group of individual heads of highly competitive companies took time out to analyze the impact of their business on the public interest and to indicate, out of their experience, the means of converting one of the most destructive vehicles of all time into an argosy of peaceful commerce. It is a plan for beating swords into plowshares which reveals the coming of age of aviation.

This action is but one of the unique aspects of the aircraft industry. The brief life-span of its pioneers has seen its growth from a "new-fangled contraption" into "the biggest aspidistra of them all." Unlike the pioneers of the transcontinental railways, who had the full power of government behind them, the aviation pioneers encountered the reluctance of a people bent on peace. Unlike the western pioneers, who exploited the natural resources of a new country, the aviation pioneers created a new technology. They brought this technology from inception to full flower. History will record their performance, in the face of great vicissitudes, as one of its most striking examples of individual initiative and enterprise.

Though pioneers seldom display the capacity to realize the full possibilities of their pioneering, our aviation pioneers *have* forecast the final step in the full utilization of air power.

In appraising the future, they draw upon past experience. They recognize the analogy between sea power and air power. They recall the history of the last half of the last century, when a beneficent sea power in the hands of a free people assured the right of innocent passage to all who proceeded on lawful occasions. Under the protection of this power, over seas trade flourished, peace reigned, prosperity prevailed, world population increased, and the arts and sciences advanced. No millennium was attained, but human progress was greater than ever before in history.

AND NOW, we Americans have created the dominant air power. This imposes on us a great responsibility. If we repeat the performance that followed World War I, allowing this power to escape into wrong hands, we will invite another war. If, however, we conserve this power, for use in conjunction with our own sea and land powers and those of other people of goodwill, we can keep the peace and promote the prosperity of the world. Strategically, there is no corner of the globe in which any combination of forces can successfully overcome us—if we determine to build and to maintain adequate land and sea power and dominant air powers.

Private industry has usually confined its thinking to the exciting game of making money. This war has brought to American businessmen the realization that unless they recognize the public interest and collaborate in it, there won't be any game left to play. The public interest is very importantly the businessman's private interest. It is, more importantly still, the personal interest of the businessman's employees and their neighbors. Public relations programs must call for more than mere news releases—there must be long-term programs of public education. This, in its broadest sense, is one of the major responsibilities of management.

Recognizing this, the Governors of the trade association of the world's youngest major industry took, at Los Angeles, their first step in a new kind of public relations. This new conception, together with the time-tested relationship between the privately owned aviation industry and government, may well set a postwar pattern for other industries.

None know better than the leaders of aviation what dynamic power lies in the technology of change. No industry has such an incomparable record in the control of this technology. No industrialists better understand the responsibility involved. And this is evident: To prevent the airplane, which America created, from becoming a Frankenstein contrivance, America must harness it to commerce.

Jesse E. Neville

—EDITOR

America's Prime Weapon—
CARRIER-BASED AVIATION

By REAR ADMIRAL DEWITT C. RAMSEY, *Chief, Navy Bureau of Aeronautics*

This is the dramatic story of how "one of the most powerful striking forces of the war" got to be that way.

THE NAVY'S carrier-based planes have emerged as one of the most powerful striking forces of the war. In spite of the fact that extra strength requirements are an essential feature of ship-based airplanes, our planes have proved to be more than a match for the enemy.

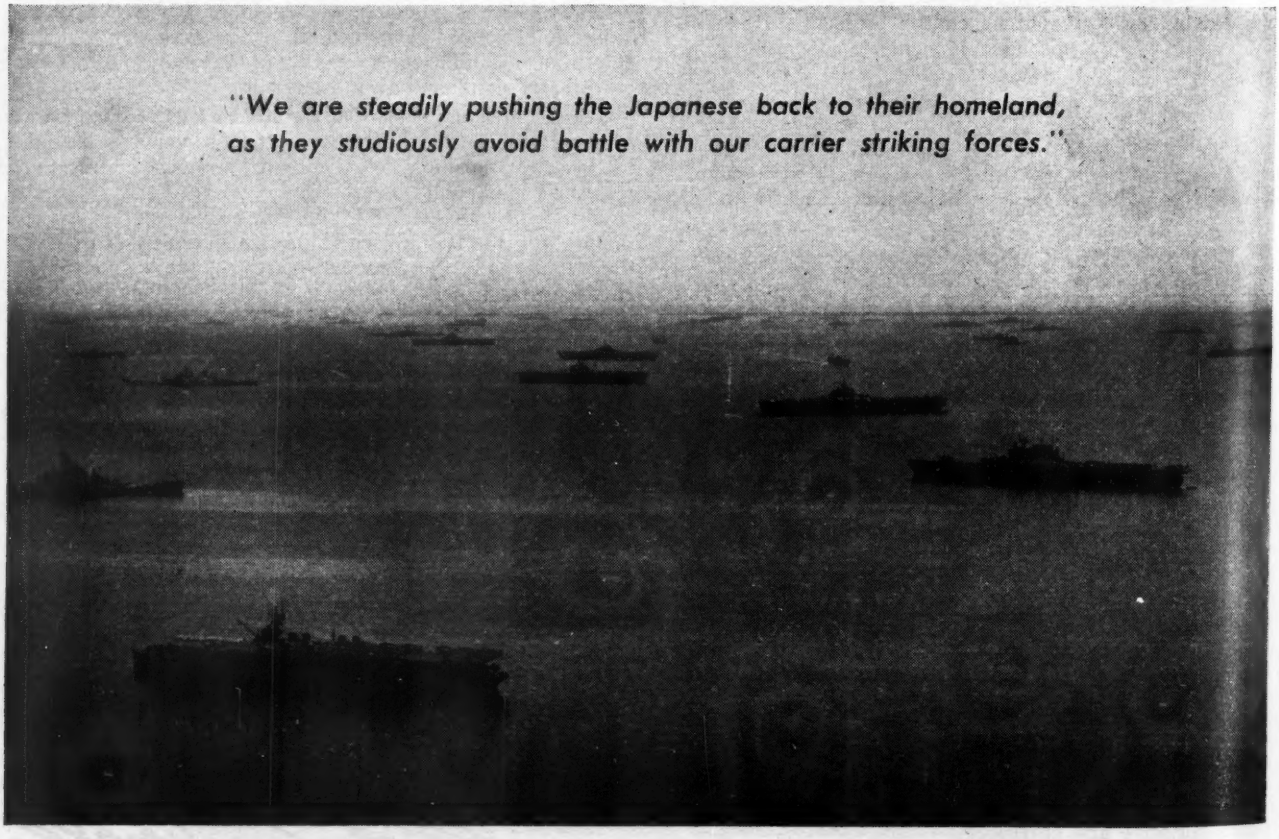
Our planes and aircraft carriers have met the acid test of battle, piling up an advantage of almost six enemy plane losses to our one, in air combat alone. Carrier aviation has definitely established itself as the spear-head in America's westward drive in the Pacific, ranging several hundred miles ahead of surface units to deliver the first devastating blows at enemy island strongholds.

This overwhelming air superiority is even more impressive when one considers that we are pitting our carrier planes against the enemy's land-based fighters. Many persons have been of the opinion that the carrier plane never could be more than a second-rate craft as a result of its weight disadvantage.

Results of the Navy's three more recent strikes prove otherwise. In these operations our carrier planes provided the entire air power, challenging Japan's powerful island defenses. At Truk on February 15 and 16, Naval aviators shot down 128 Japanese planes, destroyed eighty-two more on the ground, and sank twenty-two ships. That amazing victory cost us only seventeen planes. Three days later we struck the Marianas. Forty-eight of the enemy's planes were shot down in air combat, 87 destroyed on the ground, two ships were sunk, and eight were damaged. Only six of our planes were lost. We lashed into the strong Jap base at Palau on March 30 and April 1, shooting down 117 planes. In addition, 39 planes were destroyed on the ground, 54 more probably destroyed, 14 ships were sunk, and nine others damaged. We lost 25 planes and 18 men.

The years spent by the Navy in tireless research in aerodynamics and aircraft structures are paying off in actual combat. The enemy is footing the bill in the form of blazing planes, sunken ships, and shattered bases. That price will be stepped up as additional carriers and planes join our fleets.

The enemy already has demonstrated that he can not meet the terrific cost. We are steadily pushing the Japanese back to their homeland, as they studiously avoid battle with our carrier striking forces. The Navy has been unable to bring a Japanese carrier to action since October of 1942.


"We are steadily pushing the Japanese back to their homeland,
as they studiously avoid battle with our carrier striking forces."

Shown here is a part of the force that struck at the Marshalls. Nine carriers, a dozen battleships, and swarms of cruisers, destroyers, and supply ships are in this photograph—just a segment of the armada numbering in the multiple hundreds.

It was not until our first carrier strikes after Pearl Harbor that the Navy's designers and engineers were to learn whether the planes they had been constructing would stand up to the exacting tasks they were called upon to perform. No other aviation development had required greater efficiency and refinement in design than the ship-borne plane.

A delicate balance had to be struck between the plane and the ship, in order that both would have the highest possible performance. This meant special features in both the ship and the airplane. Space on ship board is at a premium. Every precious square foot of flight and hangar deck must be used to pack in the greatest air power. As for the airplane, space must be conserved in the takoff run; space must be conserved in landing, and space must be conserved in the overall dimensions of the aircraft. Likewise, every consideration in the structure of the ship is necessary to afford the maximum space for airplane stowage as well as an optimum arrangement for the movement and servicing of the airplane complement.

To meet these requirements, penalties and limitations in the airplane's design became immediately apparent. The carrier plane, in order to take off in the shortest possible distance, would require relatively light wing loading: that is, a larger wing, the drag of which adversely affects high speed. It would need heavier landing gear to withstand the shock of hard, short landings on an unsteady deck. It would need an arresting hook, and structural strength to engage the ship's arresting gear. To conserve space, and thus increase the number of airplanes carried, it would need folding wings—hence, the additional weight and mechanical complication of hinges.

All of these requirements tended to increase the airplane's weight and make difficult the attainment of high speed. They were requirements not imposed on land-base planes. But they had to be met if this weapon was to become an effective part of the fleet.

Research on these problems actually began November 14, 1910, when Eugene Ely, a Curtiss pilot, lifted his flimsy kite-like airplane from a 60-ft. platform built on the bow of the U. S. S. *Birmingham* at Hampton Roads, Va., to make the first successful takeoff from a ship. The Navy was mildly impressed with the possibilities of the airplane as a fleet weapon, but far from convinced.

Never one to let enthusiasm lag, Glenn Curtiss arranged for a more impressive demonstration. A platform 120 ft. long was built on the stern of the U. S. S. *Pennsylvania,* anchored in San Francisco harbor. A crude arresting gear of lines attached to heavy sandbags was rigged up across the platform. A big hook was attached to the bottom of Ely's plane, in the hope that it would engage one of the lines before the plane went overboard. As evidence of his doubt, however, Ely wound a bicycle tube around his neck and shoulders as flotation gear. He took off from a field, landed on the *Pennsylvania,* and the gear functioned satisfactorily, drag-

Rear Admiral DeWitt C. Ramsey

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

★ *"Many persons have been of the opinion that the carrier plane never could be more than a second rate craft. . . ."* ★

★ ★

★ ★

Result of five days' carrier operation against Japanese island bases

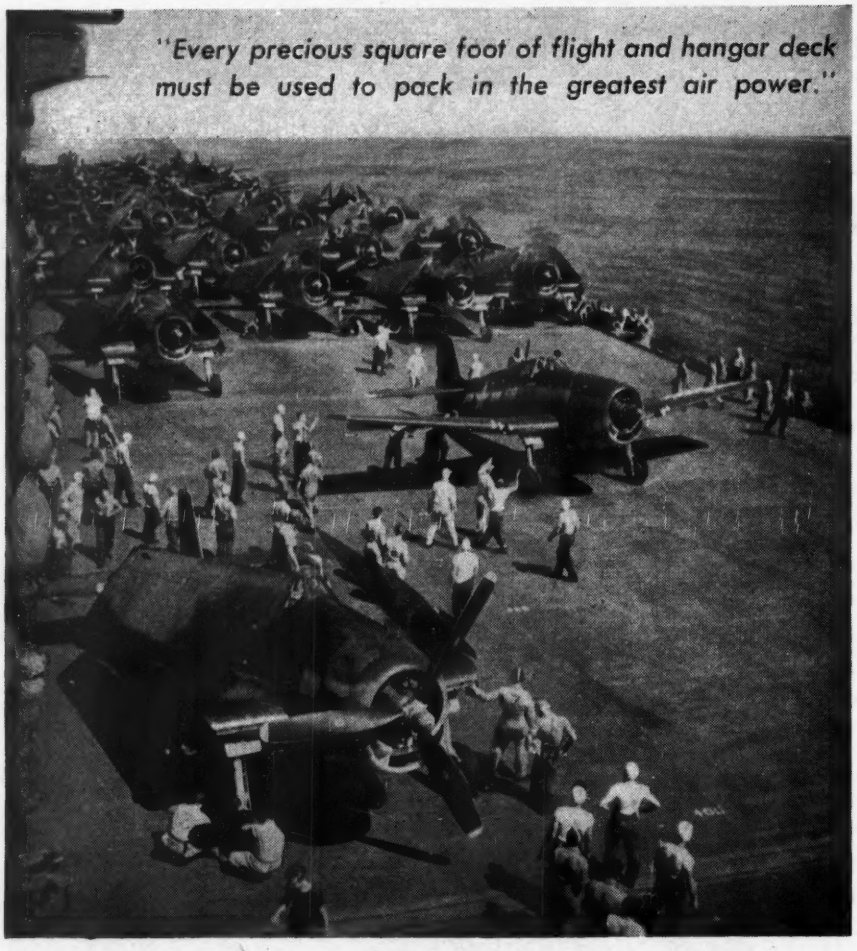
★ **Japanese plane losses..... 555** ★

★ **Japanese ships sunk..... 38** ★

★ **Japanese ships damaged..... 17** ★

★ **American plane losses..... 48** ★

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★



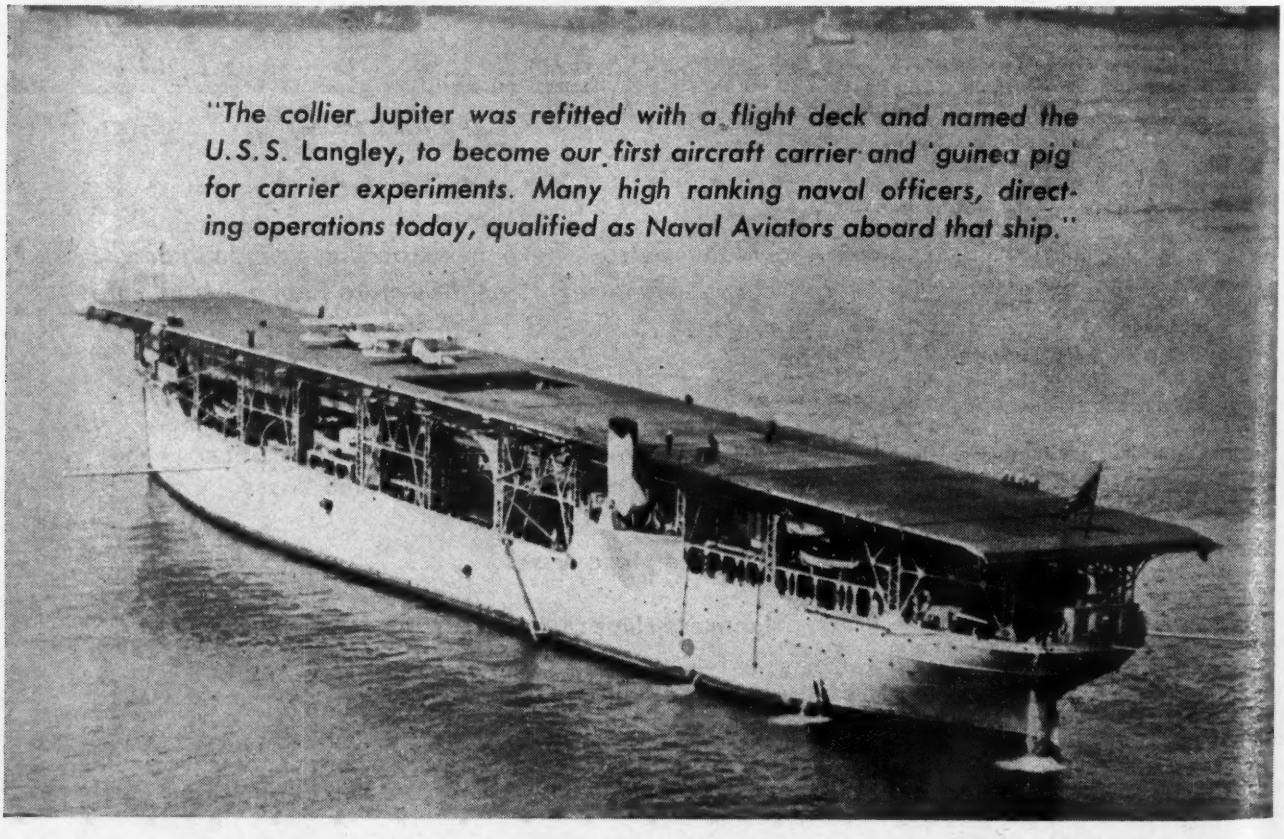
A Gruman Hellcat prepares for takeoff while Avengers and Douglas SBD's await their turn with engines warming up.

ging the plane to a stop. He turned it around and took off again to land safely at his base. The flight proved to be the birth of the aircraft carrier and the carrier borne plane.

Much remained to be done, however, before the airplane was to win a place aboard ship. Space was, and still is, precious. The many problems appeared to be insurmountable.

The few short years before the first World War offered little time for conclusive experiments, although progress was comparatively rapid. The possibility of landing floats was tested in 1911 and found to be practical. The first successful catapult launching was made in 1912. Naval aviation had proved itself to the extent that planes accompanied the winter fleet maneuvers for the first time in 1913, under the command of Lieut. (now Vice Admiral) John H. Towers. Problems of scouting and locating "enemy" vessels, mine fields, and submarines were so successfully conducted that many officers who had been skeptical of the airplane's usefulness changed their opinions at that time. As a result, the following year, the first Naval Air Station was established at Pensacola, Florida. When war was declared in 1917 the Navy had one air station, 38 Naval aviators, 193 enlisted men assigned to aviation, and 54 airplanes. Most of the developments, however, had been chiefly in the line of flying boats.

It was not until the following decade that the real possibilities of carrier warfare were completely explored. The collier *Jupiter* was refitted with a flight deck and named the U. S. S. *Langley*, to become our first aircraft carrier and "guinea pig" for carrier experiments.

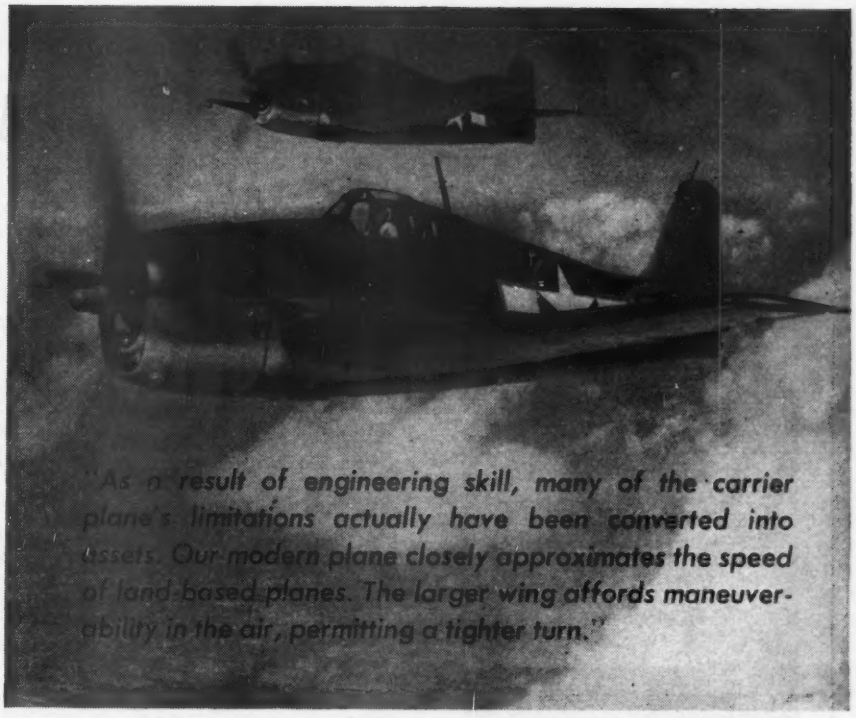

"The collier Jupiter was refitted with a flight deck and named the U.S.S. Langley, to become our first aircraft carrier and 'guinea pig' for carrier experiments. Many high ranking naval officers, directing operations today, qualified as Naval Aviators aboard that ship."

Many high ranking naval officers, directing operations today, qualified as Naval aviators aboard that ship.

Basic lessons learned aboard the old *Langley* still are apparent today. However, there is little comparison between that pioneer carrier and our modern ships. The original arresting gear on the *Langley* was an elaborate pattern of wires, raised six inches off the flight deck by a series of fiddle bridges, and purchases reeved to support weights in towers. The length of a plane's runout was adjusted by increasing or decreasing the number of steel weight plates. The pull exerted on the wires by landing planes was overcome by the weights. To prevent the planes from swerving over the side of the ship several hooks were attached to their fixed landing gears. These engaged fore and aft wires, strung nine inches apart the entire length of the deck. The arrangement was cumbersome and required constant adjusting. Tire blowouts and damage to incoming planes were frequent.

The gear was improved as a result of experience and research, and by 1929 the fore and aft wires were removed. The next major improvement was the Mark 2 arresting gear, which supplanted the cumbersome system of weights. The new

(*Turn to page* 271)



"As a result of engineering skill, many of the carrier plane's limitations actually have been converted into assets. Our modern plane closely approximates the speed of land-based planes. The larger wing affords maneuverability in the air, permitting a tighter turn."

Shown here is the Grumman Hellcat, newest of Navy fighters and one of the most perfectly engineered fighting craft in the world.

"Skillful design has been perhaps the most important factor" . . . in overcoming these handicaps.

Folding wings for efficient space utilization and wing area for quick takeoff are inherent handicaps imposed upon Navy aircraft. Here are some Grumman Avengers and Wildcats with wings folded, secured to the deck as the carrier pushes through a stormy sea.

AN AMERICAN AIR POWER POLICY

• *The attendance of the full Board of Governors of the Aeronautical Chamber of Commerce of America at the Los Angeles meeting, and the unanimous vote of the board with respect to chamber policy, is a hopeful augury for the future of the American aircraft industry.*

No industry faces greater difficulties with contract termination, disposal of surplus war goods and disposal of surplus plants. Our difficulties are at least directly proportional to our rate of expansion. Both our public and corporate responsibilities call for united effort along these lines, and we now seem on the way to get just this.

EUGENE E. WILSON,
Chairman, Board of Governors
Aeronautical Chamber of Commerce of America

LET US QUICKLY REVIEW the past as the first step toward an estimate of the future. No matter how well known the record may be to some of us, it is worth while to restate it here.

We recall that upon the outbreak of World War I, the United States was wholly unprepared. This was particularly true in aviation, for whereas Europeans had looked upon the airplane as an instrument of war, we Americans saw it as a new vehicle of peace. Thus, we entered the war with no military airplane designs and no military engines of our own. We sought to overcome this disadvantage by adapting foreign designs to automotive mass production, and belatedly trying to create new ones of our own. And though a valient effort was made, the brief 19 months of our participation was not enough to bring American designed aircraft into combat.

The sudden unexpected armistice of November 11, 1918, found us as unprepared for peace as April 17, 1917, had found us unprepared for war. We had neither adequate policy, program or organization for terminating war contracts or for the custody, storage or disposal of surplus goods or plants. As a result, there was vacillation, confusion and hardship. "War profits" proved illusory. Companies without adequate reserves or surplus failed. Automotive companies went back to automobiles. What little remained of the aircraft industry floundered in the doldrums. Some even thought the Army and Navy should design and build their own aircraft.

The Army, the Navy and the Congress took some cognizance of this situation. A number of Committees and Boards made recommendations. But nothing came of them. Then, in 1925, in response to outspoken charges by Brig. Gen. William E. Mitchell, and to an aroused public opinion, President Coolidge appointed the "Morrow Board."

This board was requested by the Secretaries of War and Navy. These requests were in turn the result of representations by the Aircraft Industry whose importance to the Army and Navy was pointed out.

The Morrow Board consisted of nine members appointed by the President of the United States. Their number included a retired general, a retired admiral, two outstanding engineers qualified in aeronautics, a member of the Senate Committee on Military Affairs, a member of the House Committee on Naval Affairs (the Hon. Carl Vinson), the Chairman of the House Committee on Interstate and foreign Commerce, a judge of the Circuit Court of Appeals, and a prominent lawyer and banker, Dwight Morrow.

The board was non-partisan and non-political, and no member was directly interested in commercial or military aviation. The character and integrity of its members was such as to assure public confidence in their findings.

It heard nearly one hundred witnesses and many conflicting opinions. At that time, the state of the aeronautical art was such that little could be drawn from experience, yet the public had strong confidence in the future of aviation. After a short but active inquiry, the board submitted a unanimous report.

Against the background of charge and countercharge incident to the Mitchell controversy, the board's findings were unexciting. Yet they were so sound in principle that the report (now out of print), deserves reading and re-reading today even by those familiar with it. Congress accepted its recommendations and embodied them in the Air Corps Act of 1926. It created the office of Assistant Secretary for Air in the Departments of War, Navy and Commerce.

The board held, in effect, that a strong air force is vital to national security, that the backbone of this air force must be a strong, private industry, and that a long term, continuing program of procurement is essential to the creation of adequate engineering staffs and the acceleration of the new technology. Thus, the board fixed responsibility for American airpower jointly upon government and private industry.

We take pride in the fact that the aircraft industry has fully discharged its responsibilities, even though at times the people's desire for peace caused them to falter in support of the Morrow Board policy. Whereas, in World War I, we borrowed aircraft from our Allies, in World War II, we supplied them.

The board realized the vital strategic importance of advanced engineering. It recognized the handicaps inherent in government design and appreciated the need of private competition for the development of creative design staffs. It also stressed the impracticability of maintaining a peacetime industry adequate to the requirements of war. It emphasized the need for rapid expansion in emergency and visualized it taking place around a small but potent aircraft industry. This forced aircraft designers to conceive an entirely new theory of quantity production, one that relieved it of the need for freezing designs, and permitted it to expand phenomenally while introducing new and better models.

As contemplated by the Morrow Board,

(*Turn to page 279*)

A Recommendation for an American Air Power Policy

The Board of Governors of the Aeronautical Chamber of Commerce of America, in order to "provide for the common defense, promote the general welfare and secure the blessings of Liberty to ourselves and our posterity", and in order to insure that the airplane which America created shall be used to maintain peace and secure the blessings of peace to mankind, do unanimously recommend the early formulation of an American Air Power Policy under the following guiding principles:

The United States should maintain an *Air Power* sufficient (in conjunction with other forces) not only to win this war, but also, to keep the peace:

I. By maintaining adequate *Air Forces* at such strength and in such state of readiness as to preclude a successful assault upon our country or its possessions.

II. By acquiring and maintaining *Air Bases* essential to our security and that of overseas trade.

III. By facilitating the orderly and economic expansion of domestic and international *Air Transport* and of private flying.

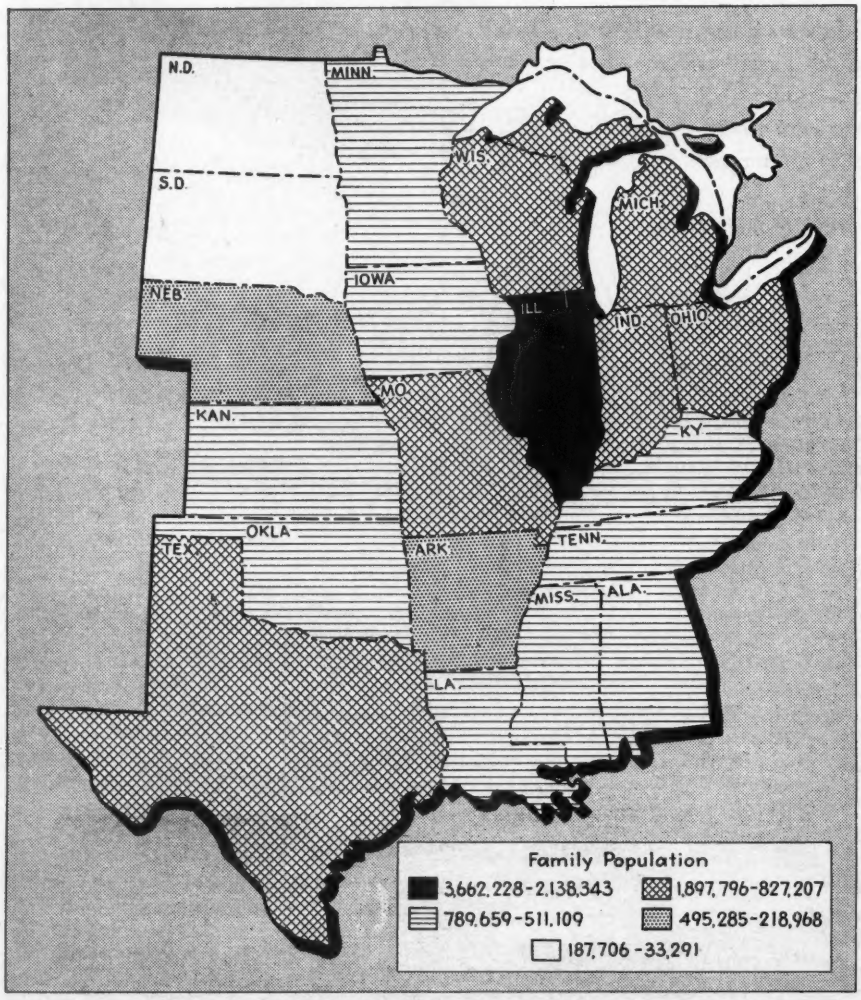
IV. By preserving a strong *Aircraft Manufacturing Industry*.

HERE ARE YOUR MARKETS

PART II—EAST AND WEST NORTH CENTRAL, EAST AND WEST SOUTH CENTRAL REGIONS

By **JOHN FOSTER, JR.,** *Associate Editor, "Aviation"*

Second of "Aviation's" outstanding regional range-finding series detailing basic data for merchandising aircraft and aircraft parts . . . Covered this month are all pertinent market criteria for the middle United States



Mid-portion of United States, embracing five East North Central, four East South Central, seven West North Central, and four West South Central states, covers five ranges of family populations ranging from 152,043 in North Dakota to 2,192,730 in Illinois. West North Central states have greatest variety, covering three of five ranges.

BY ALL MEASURABLE marketing standards, the five East North Central states of Ohio, Indiana, Illinois, Michigan, and Wisconsin should become well populated with distributors and dealers of aircraft and aircraft parts and accessories. Good livings for these distributors and dealers, as well as profitable outlets for manufacturers, should be found there—for these states show up consistently strong when evaluated against market criteria, as is revealed in our accompanying Table IV.

Ohio's 1,897,796 families, for example, own 1,599,678 passenger automobiles—or 84 per hundred families, better even than the "hot" markets of New York. The Ohio families, 5.4 percent of the national total, have 6.28 percent of the buying income and make nearly 6 percent of the nation's retail sales possible.

The Buckeyes' acceptance of aviation is indicated by the fact that the state had, on Oct. 1, 1941 (the last available listing) 4,246 non-airline pilots and 1,318 registered aircraft (5.6 percent of all private planes in the country), leading the other four states of the region in each category. In the number of airports—113—Ohio is second to only one other state in the region, but with 2.74 airports per 1,000 sq. mi., it again takes first place in that section of the country.

Evaluated on the basis of the measurable data of family population, buying income, retail sales, automobile ownership, aircraft and pilot registrations, and airport facilities, Ohio stacks up as a Class A aviation market, ranking as the fifth strongest among the 48 states.

Neighboring Indiana, while geographically nearly as large as Ohio, has just about half the family population, 961,498, or 2.5 percent of the national total. Here again, though, the percentages of buying income and retail sales are higher, standing at 2.64 and 2.65 percent, respectively. The ratio of automobile ownership con-

tinues high in the Hoosier state, too; for the total stands at 830,009, or 86 per hundred families.

Of the nation's 90,603 non-airline pilots registered on Oct. 1, 1941, 2,019 were listed in Indiana, and 643 of a total of 23,496 non-airline planes were registered there. As for flight facilities, a total of 57 airports means the state has 1.62 ports per 1,000 mi. Combining the various factors, we find Indiana has an aviation market rating of Class B, standing in eleventh place on an individual state basis.

Illinois, bolstered by the largest population in the East North Central region, shapes up as a Class A market, its weighted rating putting it in fourth place among the states. Its family population of 2,192,730 measures out to 6.2 percent of the national total, a population with 6.74 percent of the national buying income, accounting for 6.29 percent of the retail sales. Automobile ownership ratio drops below that of the other states, totaling 1,699,596, or 78 per hundred families. Despite the greater family population, Illinois' aircraft and pilot registrations are just under Ohio's, standing at 1,299 and 4,133. And despite a greater land area, it has fewer airports—a total of 74, or 1.32 per 1,000 sq. mi., the majority of which are to be found in the eastern and northern parts of the state.

Michigan's passenger auto registrations of 1,399,795, just a shade over one for each of the 1,396,014 families, must be carefully weighed, since Detroit was, and no doubt will be again, the very heart of the automobile manufacturing industry. The Wolverines have, however, consistently good ratings in other criteria; for as compared with 3.8 percent of the family population, the state has 4.73 percent of the buying income and does 4.63 percent of the retail sales of the country. Its 945 aircraft figure out to an even 4 percent of registrations, and the 3,333 pilot registrations compare favorably with other states. Michigan's 133 airports give it 2.33 per 1,000 sq. mi., second only to Ohio among the East North Central states, a factor which helps give the state a Class A market rating. On a weighted basis, Michigan is rated as seventh most important of the 48 states.

Population-wise, Wisconsin is smallest of the five states, for its 827,207 families are 2.3 percent of the nation's. These families have 2.43 percent of the national buying income, and use it to make 2.44 percent of the retail sales. The 453 aircraft registered is the smallest total in the region, as is the total of 1,429 non-airline pilots. Likewise, the 52 airports comprise the lowest number, and the fact that there are but .95 per 1,000 sq. mi. tends to give the Badger state a Class B market rating, putting it at 13th place in the individual state listings.

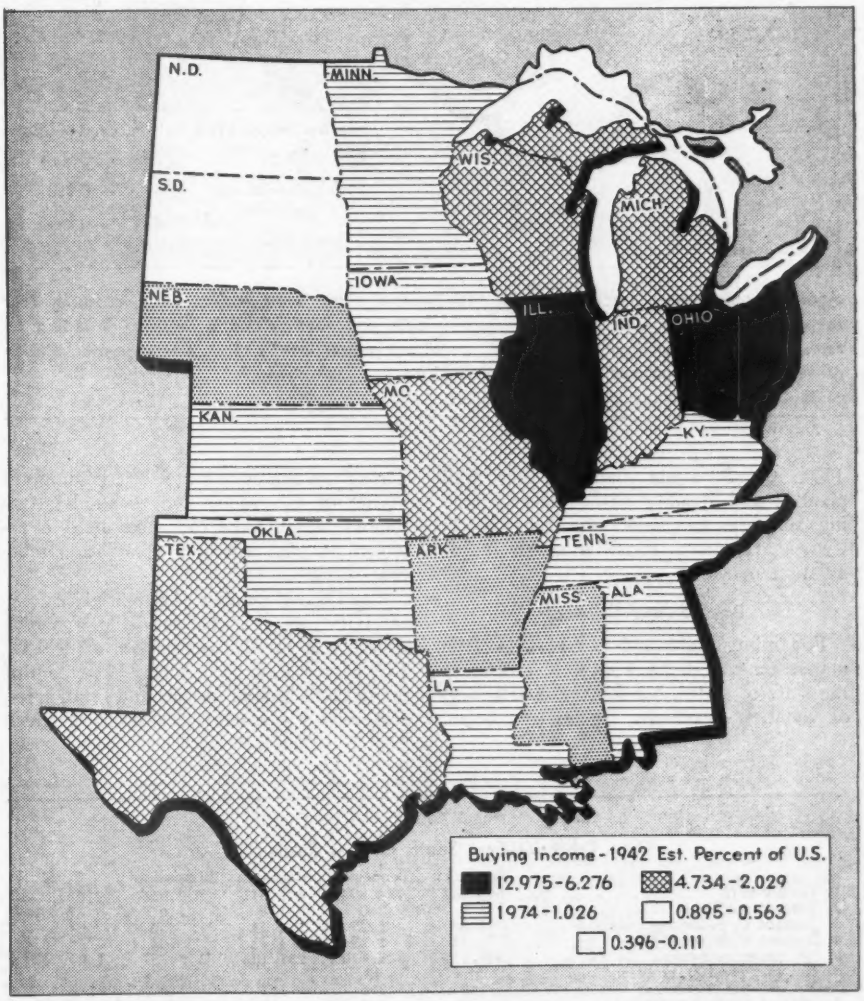
Consistency of the East North Central states' ratings combine to make them the second most important region in the country. This is clearly shown by the regional totals, summing to a family population of 7,275,245, or 20.2 percent of the national total, with 22.82 percent of the buying income and 22 percent of the retail sales. Automobile ownership of 86 passenger cars per hundred families is exceeded only by the Pacific region.

Generally speaking, terrain would appear to have little effect on selection of distribution locations, but weather, particularly in northern Michigan and Wisconsin, would undoubtedly be a prominent factor, especially on the basis of today's personal aircraft utility. For at least part of the year, however, both these states offer unusual possibilities for widespread use of waterbased craft, a factor which should always be borne in mind in any consideration of distributor or dealer locations.

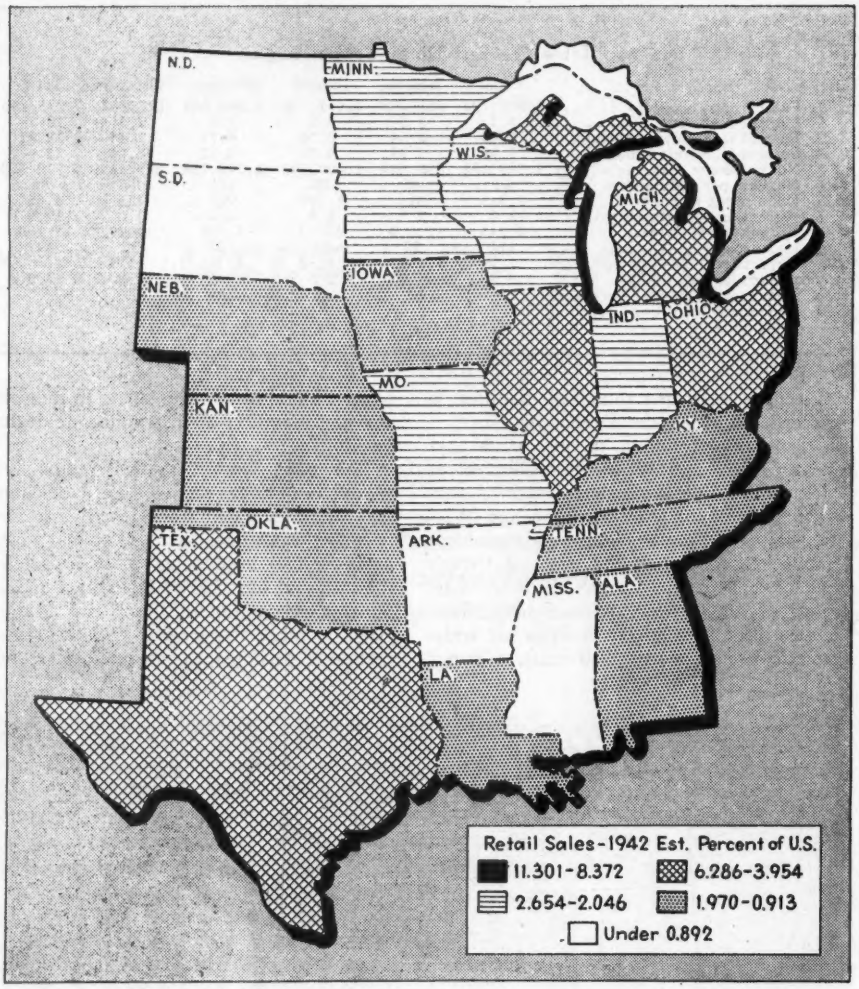
The East North Central region has always been known as good airplane country, for private flying developed early and held to a high level in these states. This past aviation acceptance is evidenced by the fact that the total of 15,160 non-airline pilots exceeds that of the No. 1 Middle Atlantic marketing region and the registration of 4,658 planes runs a close second.

Table IV—East North Central Region

	Ohio	Indiana	Illinois	Michigan	Wisconsin	Total
1. Family pop.	1,897,796	961,498	2,192,730	1,396,014	827,207	7,275,245
2. Percent Nat'l pop.	5.4	2.5	6.2	3.8	2.3	20.2
3. Percent U. S. buying income	6.28	2.64	6.74	4.73	2.43	22.82
4. Percent U. S. retail sales	5.99	2.65	6.29	4.63	2.44	22.
5. No. passenger cars	1,599,678	830,009	1,699,596	1,399,795	691,340	6,220,358
6. No. cars per 100 families	84	86	78	100	84	86
7. No. aircraft registered	1,318	643	1,299	945	453	4,658
8. Percent aircraft registered	5.6	2.7	5.6	4.0	2.0	19.9
9. No. pilots registered	4,246	2,019	4,133	3,333	1,429	15,160
10. No. airports	113	57	74	133	52	429
11. Airports per 1,000 sq. mi.	2.74	1.62	1.32	2.33	.95	
12. Percent airports	3.8	1.9	2.5	4.6	1.8	14.6
13. State market rating	A	B	A	A	B	
14. Region market rating						2



Buying income percentages in four mid-U. S. marketing regions also cover five ranges, from .29 of national total in North Dakota to 6.28 in Ohio and 6.74 in Illinois. Note consistently high averages of East North Central region, embracing Ohio, Indiana, Illinois, Michigan, and Wisconsin.



Again in retail sales percentages, 20 mid-America states show wide variety, covering four ranges, as compared with but two in both Middle and South Atlantic regions. It should be remembered, however, that many of these states are predominantly rural, where greater portion of needs can be produced by individual families.

This record would indicate that well planned and steadily pushed merchandising activities can make the East North Central region a consistently profitable aviation market.

East South Central

For mint juleps and horse races (the non-street car derby kind), Kentucky is the state of states, but for the distribution of aviation products, it has its peers. That's not the state's fault; it is simply a matter of geography and economics, two factors which have too often been overlooked in past attempts at aviation merchandising.

The limited number of potential customers is clearly indicated in Table V, which shows the family population of 698,538 (1.9 percent) and 1.08 and 1.24 percent of the nation's buying income and retail sales, respectively. Further evidence is given by aviation-acceptance criteria, for the 168 registered aircraft comprised but 0.7 percent of those listed for the country, and the 547 non-airline pilots make up the smallest total in the East South Central region. This may be due in large part to the fact that the state has but 22 airports—0.55 per 1,000 sq. mi., a contributing factor in the state's rating as a Class C. market, or 28th on a state-by-state rating.

Tennessee provides a contrast especially noticeable in the number of pilots, for while it has 1,582 registered, its family population is not much higher, standing at 714,894, or 2 percent of the nation's total. Although this population is higher, the state's passenger auto ownership is low, the figure being 323,926, against Kentucky's 349,116. By other marketing standards, the Volunteer state follows the pattern, with 1.25 percent of the buying income and 1.35 percent of the retail sales; aircraft registration of 296 and 28 airports, all of which help establish Tennessee as a Class C market, 24th most important among the 48 states.

Alabama is the third of the East South Central states to enter the Class C market bracket, and its weighted rating is 26th in the state listing. This is based partially on the 673,815 family population, 1.11 percent of the buying income and 1.31 percent of the retail sales, and passenger car ownership of 251,202, or 37 per hundred families. Aircraft registration is exactly the same as that in Kentucky—168—but the number of pilots is higher at 980. With 51 airports, or 1 per 1,000 sq. mi., Alabama has more than the other three states in the region.

Although it has a greater area than Kentucky and Tennessee, Mississippi has the smallest family population in the region—534,956, or 1.6 percent. Moreover, both buying income and retail are the smallest, standing at .56 and .63 percent, and the figure of 175,357 passenger cars is the lowest in the region. The 145 aircraft registered follows the pattern of other three states, but the 745 non-airline pilots give it third place in this respect, and the 47 airports give it second place in this category. These factors combine to make Mississippi a Class D market, ranking in 33rd place among the states.

Combining the various data, we find that the East South Central region has a family population of 2,622,203, or 7.3 percent of the U. S. total, but that buying income is but 4 percent and retail sales stand at 4.53 percent. Despite the fact that the actual area covered is greater than in other regions, the automobile ownership totals but 1,099,601 or less than that of some individual states. The average of 42 per hundred families is lowest for any of the nine marketing regions. The aircraft as registered numbered 777, or 3.4 percent of national total, and the 3,854 non-airline pilots have 148 airports available for use.

Although the East South Central region measures out in last place compared with the other eight regions, there are several factors to be considered in setting up a distribution organization. Mississippi and Alabama both, for example, have had the

Table V—East South Central Region

	Kentucky	Tennessee	Alabama	Mississippi	Total
1. Family pop.	698,538	714,894	673,815	534,956	2,622,203
2. Percent nat'l pop.	1.9	2.0	1.8	1.6	7.3
3. Percent U. S. buying income	1.08	1.25	1.11	.56	4.0
4. Percent U. S. retail sales	1.24	1.35	1.31	.63	4.53
5. No. passengers cars	349,116	323,926	251,202	175,357	1,099,601
6. No. cars per 100 families	50	45	37	33	42
7. No. aircraft registered	168	296	168	145	777
8. Percent aircraft registered	.7	1.3	.8	.6	3.4
9. No. pilots registered	547	1,582	980	745	3,854
10. No. airports	22	28	51	47	148
11. Airports per 1,000 sq. mi.	.55	.66	1.00	1.00	
12. Percent airports	.7	1.0	1.8	1.6	5.1
13. State market rating	C	C	C	D	
14. Region market rating					9

benefits of other southern states in that the Army and Navy have concentrated their air-arm training programs in this part of the country; this intangible "educational" stimulus may easily alter the course of future aviation behavior in that region, as will other factors which can best be evaluated in considering all the regions as a unit, as will naturally be done as a part of this series.

West North Central

The seven states of Minnesota, Iowa, Missouri, North and South Dakota, Nebraska, and Kansas, comprising the West North Central region, give quite a cross section of market ratings—ranging from Class B to Class E and together making up the fifth most important of the nation's nine regions.

That aircraft distributors and dealers as well as parts and service organizations can be successfully operated in this region is borne out by the measurable data compiled for this series, as shown in Table VI; their locations can best be plotted when the region is considered in its relation position to the country as a whole.

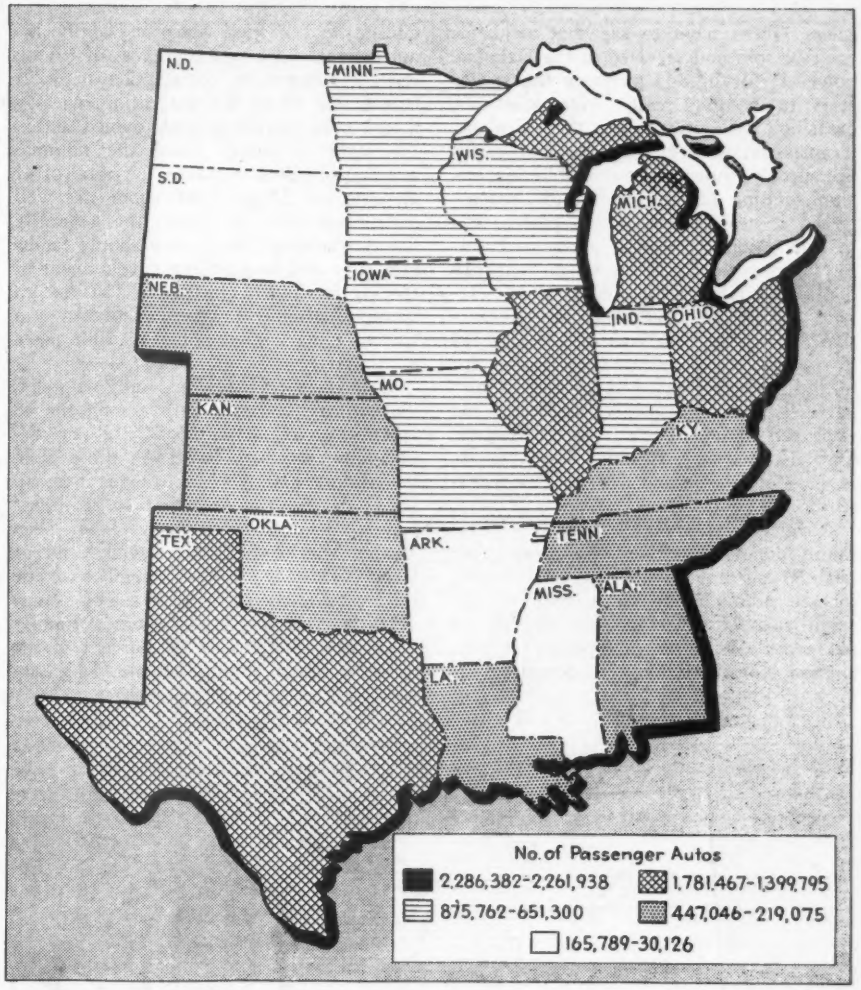
In analyzing the individual states, Minnesota has a Class B market rating, and stands at 14th place in the state ratings. This is based on its family population of 728,359, which is 1.9 percent of the national total. Buying income amounts to 1.89 percent, but the state accounts for 2.05 percent of the country's retail sales. Transportation requirements are indicated by ownership of 698,238 passenger cars, or 96 per hundred families, a healthy ratio in any man's league.

Minnesota had 1,928 non-airline pilots registered on Oct. 1, 1941, according to the last available listing covering what can be called fairly normal times, and thus an average past acceptance of aviation is indicated. Its registration of 556 civilian planes, amounting to 2.4 percent of the national total, was second highest among the seven states of the region, and 46 airports—0.57 per 1,000 sq.mi.—is about average for the country. It should be remembered, however, that Minnesota has a better-than-average number of lakes from which to operate water-based or amphibious craft, especially as a seasonal proposition during the summer vacation period.

Iowa, just below Minnesota on the map, is likewise just below it in aviation market ratings, the final tabulations putting it in Class B also; its weighted rating ranking it in 17th position among the states. With 1.8 percent of the nation's family population, Iowa had 1.61 percent of the buying income and makes 1.77 percent of the retail sales. Its ownership of 651,300 passenger cars is at a ratio—93—slightly below that prevailing in Minnesota. A total of 1,896 non-airline pilots lived in the heart of the corn-hog belt, and among them they owned 511 planes, 2.2 percent of the national registrations. Although Iowa has the same number of airports as Minnesota—46—the state's smaller area gives it .82 ports per 1,000 sq.mi.

Missouri, a Class B aviation market and in tenth place on the state-by-state ratings, measures out as the most promising in the West North Central region, for its family population of 1,068,642 comprises 3.1 percent of the U. S. total. Two important percentages, however, are lower, buying income standing at 2.40 and retail sales at 2.39, and its automobile ownership of 728,268 is at a ratio lower than all other states in the region. A total of 2,789 non-airline pilots meant the state ranked seventh in the nation, and registration of 631 aircraft gave it tenth place on a nation-wide basis. With 56 airports, Missouri flyers had .81 ports per 1,000 sq.mi.

Several factors, stemming largely from sparse population, combined to make both North and South Dakota Class E markets for aviation products; for they have but 0.5 and 0.6 percent of the nation's family population, respectively; but .29 and .30 percent of the buying income; and make .34 and .37 percent of the nation's retail



Note extremely close correlation between passenger automobile registrations shown here, and retail sales percentages by 20 states in four mid-U. S. marketing regions. Ranges for both criteria are exactly same for all states except Iowa, where automobile ownership rating is one class higher than for retail sales.

Table VI—West North Central Region

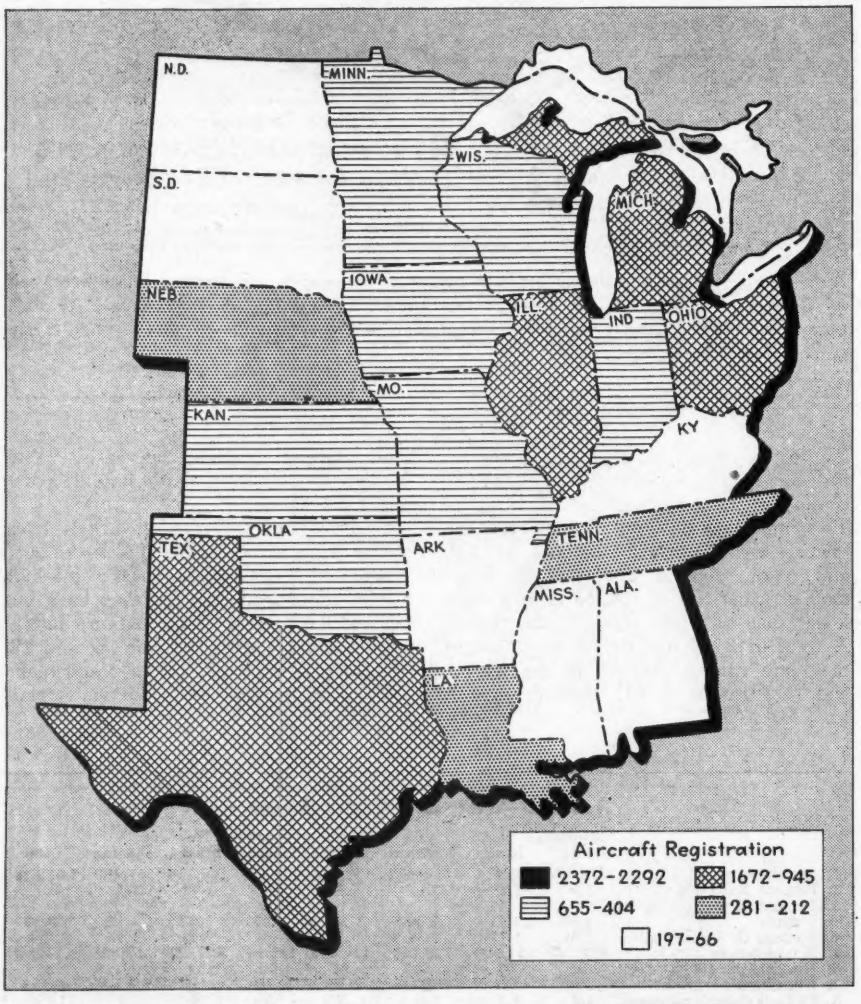
	Minnesota	Iowa	Missouri	North Dakota	South Dakota	Nebraska	Kansas	Total
1. Family pop.	728,359	701,824	1,068,642	152,043	165,428	360,744	511,109	3,688,149
2. Percent Nat'l pop.	1.9	1.8	3.1	.5	.6	1.12	1.6	10.7
3. Percent U. S. buying income	1.89	1.61	2.40	.29	.30	.80	1.12	8.39
4. Percent U. S. retail sales.	2.05	1.77	2.39	.34	.37	.91	1.22	9.06
5. No. passenger cars.	698,238	651,300	728,268	127,640	148,163	327,658	463,648	3,144,915
6. No. cars per 100 families.	96	93	68	84	90	91	91	85
7. No. aircraft registered.	556	511	631	124	110	212	494	2,638
8. Percent aircraft registered	2.4	2.2	2.6	.5	.5	.9	2.1	11.2
9. No. pilots registered.	1,928	1,896	2,789	618	645	1,205	2,272	11,353
10. No. airports.	46	46	56	25	24	41	61	299
11. Airports per 1,000 sq. mi.	.57	.82	.81	.35	.32	.53	.74	
12. Percent airports.	1.6	1.6	1.9	.9	.8	1.5	2.2	10.5
13. State market rating.	B	B	B	E	E	D	C	
14. Region market rating.								5

sales. This is not to say that airplanes can't be sold and serviced in the Dakotas, however, for in this territory the spaces start to become really wide open—increasing the utility of the airplane. Transportation needs in the two states are clearly shown in automobile ownership, totaling 127,640 and 148,163, respectively, a healthy number in comparison to population. Aviation acceptance follows pretty closely to the norm, with 618 non-airline pilots registered in North Dakota and 645 in South Dakota. Respective aircraft registrations of 124 and 110 give each state approximately 0.5 percent of the nation's total, and 25 and 24 airports each give respectively .35 and .32 improved landing facilities per 1,000 sq.mi. On individual state ratings, South Dakota is in 41st place, and North Dakota in 43rd.

Although Nebraska's largely - rural family population of 360,744 accounts for but .80 percent of the nation's buying income and makes .91 percent of the retail sales, it owns a total of 327,658 passenger cars, or 91 per hundred families, a good indication that transportation facilities hold a high place in family requirements. Past acceptance of flying itself is shown by registration of 1,205 non-airline pilots, but the ratio of nearly 6 to 1 over the 212 aircraft owned within the state is nearly twice the national average of pilots-to-planes. A total of 41 airports, or .53 per 1,000 sq.mi. are well distributed over the state; the generally flat character of the terrain should facilitate easy and inexpensive development of landing facilities. On the basis of present measurable data, however, Nebraska is a Class D market, standing in 30th place as a state.

Kansas is this region's only Class C market, and it ranks 20th among the 48 states. Its registration of 2,272 non-airline pilots is third highest in the region, but ownership of 494 planes gives it fourth place, despite the fact that three major league manufacturers have long been located within the state and that its 61 airports are the highest number to be found in any one state in the region. Non-aviation criteria are as follows: Family population, 511,109, or 1.6 percent of the national total; buying income, 1.12 percent of the U. S. aggregate; retail sales, 1.22 percent of the U. S. total; and passenger car ownership, 463,648, or 91 per hundred families.

The seven West North Central states thus appear to comprise around 10 percent of the totals of the various criteria. The total family population of 3,688,149 is 10.7 percent of the national total; the buying income represents 8.39 percent of the total; retail sales come out at 9.6 percent, and passenger car ownership of 3,144,915 is a little better than 10 percent. Registrations of 2,638 aircraft amount to 11.2 percent, and the 11,353 registered pilots in the various states follow much the same ratio.



On index of aircraft registrations, East North Central region has two particularly good states—Ohio and Illinois. They have 1,318 and 1,299, respectively, putting them in fourth and sixth place among all states in this category. In West South Central region, Texas' registrations of 1,311 put it in fifth place on nationwide basis.

West South Central

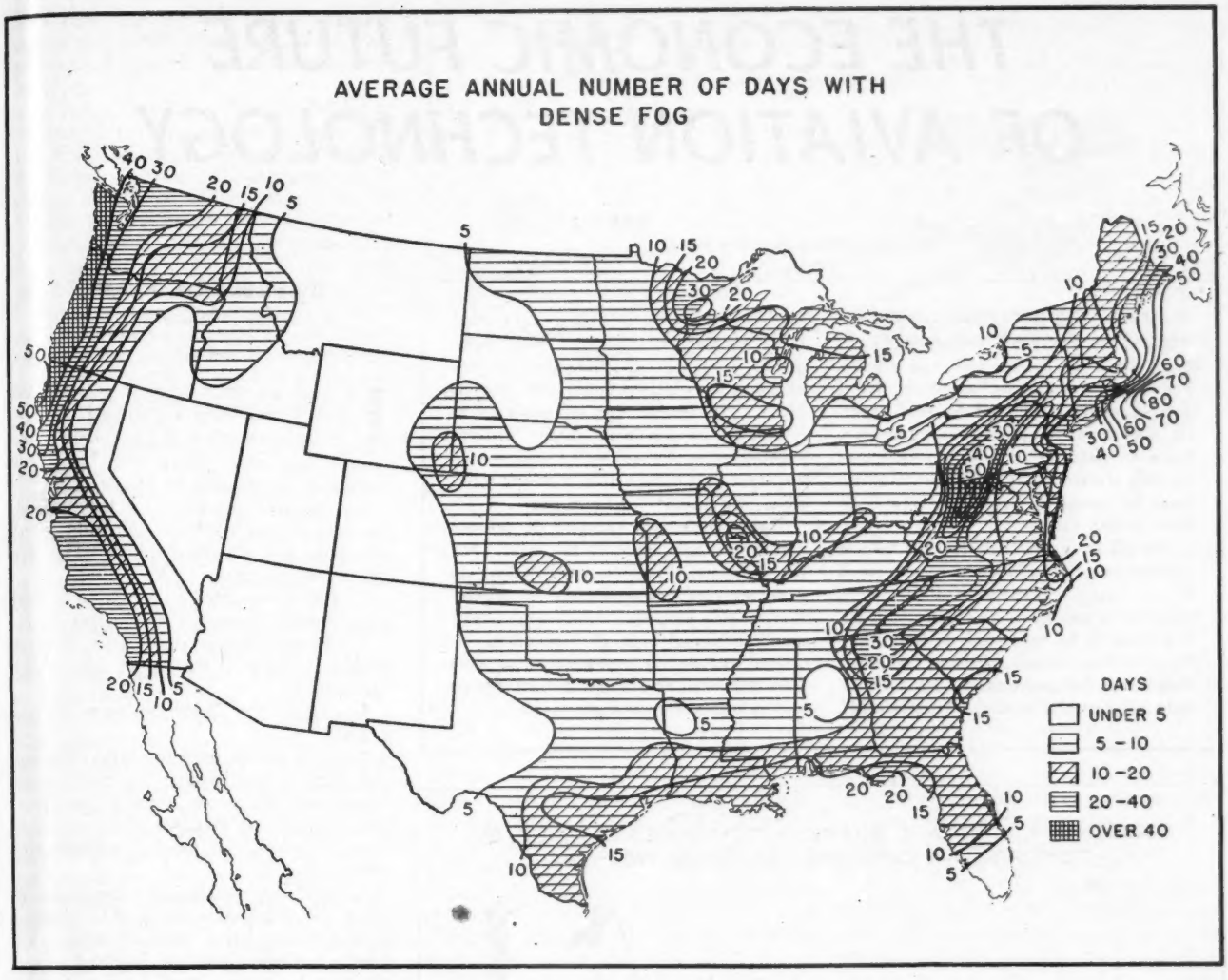
In the West South Central region, two states—Texas and Oklahoma—have always been known as flyers' states; their people were quick to adopt the airplane both for pleasure and business. With Arkansas and Louisiana, they make up the sixth most important marketing region in the country, as the data in Table VII shows.

As an individual state, Arkansas is in 34th place, measuring out as a Class D aviation market. Though they may not buy airplanes—only 190 were registered—Arkansans like to fly, for pilot registrations totaled 1,098. With 37 airports, or .71 per 1,000 sq.mi., Arkansas has the lowest ratings in the region for these two categories.

The 495,825 family population making up 1.4 percent of the American total have but .58 percent of the U. S. buying income and account for .66 percent of the retail sales. The total of 165,789 passenger cars owned is the lowest in the region, and the ratio is in the same place, for it stands at 33 per hundred families.

By comparison, Louisiana's 592,528 family population is 1.7 percent of the nation's; with 1.23 percent of the buying income, 1.31 percent of the retail sales, and total passenger car ownership of 249,068. Louisiana's 1,331 non-airline pilots owned 267 planes, 1.2 percent of the national total, and the state has available 42 airports, an average of .81 ports per 1,000 sq.mi. Consideration of the state as a market should include the greater-than-average amount of usable water for amphibians or float planes. On the basis of present data, though, the state tallies up as a Class C market, in 25th place.

Oklahoma's ambitious plans for becoming an air center may eventually change the state's rating, and such developments should be watched carefully. But on the basis of present measurable data, the state is in Class B, its individual ranking being 19th among the 48. Family population of 610,481 is 0.1 percent greater than that in Louisiana, but the 1.03 percent of the buying income and 1.07 percent of U. S. retail sales are both lower. Automobile ownership, on the other hand, is considerably higher at a total of 420,194 or 69 for every hundred families. In straight aviation criteria, Oklahoma's figures are all higher, for non-airline pilot registrations were recorded at 2,322 and aircraft



As guide to weather conditions to be generally expected through United States, this government map shows distribution of dense fog (average annual number of days).

registrations at 480, or an even 2 percent of those throughout the country. Seventy-nine airports already in existence give the state 1.11 ports per 1,000 sq.mi.

Texas, having the highest figures in the region in all but one category—in most cases accounting for over half the totals chalked up by the West South Central states—has a Class A rating, for it is sixth in the state rankings. The number of aircraft owned, for instance, is 1,311 or over 5½ percent of the nation's total, and here we have the highest ratio of planes owned to pilots registered, the latter figure standing at 5,912. Only category in which the Lone Star state takes second place is in airports per square miles—.85—even though the total of 225 is more than half of the region's total. Owning a total of 1,172,617 passenger cars, Texas' family population of 1,678,396 is 4.8 percent of that of the country, and these families have 3.84 percent of the buying income and make possible 4.06 percent of the country's retail sales.

Again in the West South Central region, figures closely approaching 10 percent of the national total show up frequently, the family population total of 3,377,230, for example, hitting 9.7 percent. On buying income and retail sales, however, they drop some, standing at 6.68 and 7.09, and the total of 2,007,668 passenger car registrations is somewhat under 10 percent also. The 2,248 planes owned amount to 9.7 percent, with 10,663 non-airline pilots standing at around 11 percent and 383 airports making up 13.3 percent of the national total.

Aside from these measurable data, though, there are several less tangible factors to consider. Texas, Oklahoma, and Louisiana have all seen a tremendous growth in military flying through headquartering of the Army Air Forces Training Command in Texas and concentration of flight training along the southern "good weather" belt of the country. Natives of Texas and Oklahoma especially have been extensive automobile travelers; in the days before rubber and gasoline rationing, driving 100 mi. to a dance or favorite eating place—and back the same evening—was accepted as commonplace. The distances, too, are right down the airplane's alley, for as the weary Eastern motorist once said, "No matter where you're going, when you get to the middle of Texas you're halfway there."

Table VII—West South Central Region

	Arkansas	Louisiana	Oklahoma	Texas	Total
1. Family pop.	495,825	592,528	610,481	1,678,396	3,377,230
2. Percent nat'l pop.	1.4	1.7	1.8	4.8	9.7
3. Percent U. S. buying income	.58	1.23	1.03	3.84	6.68
4. Percent U. S. retail sales	.66	1.31	1.07	4.06	7.09
5. No. passenger cars	165,789	249,068	420,194	1,172,617	2,007,668
6. No. cars per 100 families	33	42	69	70	59
7. No. aircraft registered	190	267	480	1,311	2,248
8. Percent aircraft registered	.9	1.2	2.0	5.6	9.7
9. No. pilots registered	1,098	1,331	2,322	5,912	10,663
10. No. airports	37	42	79	225	383
11. Airports per 1,000 sq. mi.	.71	.81	1.11	.85	
12. Percent airports	1.3	1.5	2.8	7.7	13.3
13. State market rating	D	C	B	A	
14. Region market rating					6

THE ECONOMIC FUTURE OF AVIATION TECHNOLOGY

PART I

• RAPID TECHNOLOGICAL PROGRESS of recent years has opened vast new vistas of commercial opportunity. For the time being, technology is at war and is vastly stimulated by war needs. Its application to peacetime commerce, however, poses as complex a problem as its very development, and that problem must be solved if our technology is to have lasting value.

We all know that aviation has infinite peacetime application which will result in an improved economy. Inherently, aviation is power; is energy. Actually, it has yet to be harnessed; to be geared to economy. How? When? Where? These are vital questions.

In this special series of studies, Mr. Flader casts some revealing light upon these perplexing problems. This initial article presents his discussion of the economy in which aviation will take its place. He asserts that aviation's capabilities as an economic force "depend entirely upon the ability of commercial airplane manufacturers to produce types which will operate at lower cost".

These articles will appraise the present and foreseeable types in this light. For the first time, therefore, we shall have an economy yardstick applied to jet propulsion, engine-propeller combinations, and combinations of both of these units.

This stimulating appraisal may well form the basis for future aircraft design and future commercial planning.

By FREDERIC FLADER
Consulting Aeronautical Engineer

IN THE MAINTENANCE of a livelihood and in providing a standard of prosperity above that of the minimum or subsistence level, there are only four factors of importance to people:

1. Natural products of the ground, sea, and air, such as food, minerals, forest products, and all other things which are given free by nature.
2. Labor expended by people to convert these natural resources into usable forms.
3. Transportation, or location of these usable products in the places where they are needed.
4. Time—the fourth measure of real value.

Not[illegible].g can be used to sustain life, nor can semi-necessities and luxuries be obtained, unless people expend energy or work to add one or more of the values of form, location, and time to natural products.

Air must be breathed into the lungs. A clear cold drink of water may be obtained from a spring but it must be lifted to the mouth and swallowed to be used. Food must at least be picked from a tree or dug out of the ground. To be of any value, things must be located where they are usable and at the time when needed. A lost battalion may need tanks and ammunition which have no value unless they are delivered where needed, and before the battle is lost.

All commodities must be provided with location and time utility. Usually this must be done by transportation on a schedule. The means of transportation must be determined from a consideration of the second measure of value, that is by that means which will locate the commodity where it is needed at the time when needed with the least cost in work or man-hours. Time may be of great importance, in which case an expenditure of man-hours above the minimum attainable may be justified.

Raw products and heavy materials go by the cheapest method because here the time element is usually that of continuous flow and delivery, it being of little importance how long enroute. The airplane as a means of transportation has been of importance only because of its time value. There are limitations regarding the value of time saved. Mentzer and Nourse have shown that there is no need for greater speed than that provided by an airplane which could leave the West Coast at the close of a business day and arrive at the Atlantic seaboard at the start of the next business day. The air-

PASSENGER, MAIL, AND EXPRESS TON-MILES CARRIED BY DOMESTIC AIR CARRIERS FOR YEARS 1935-1940

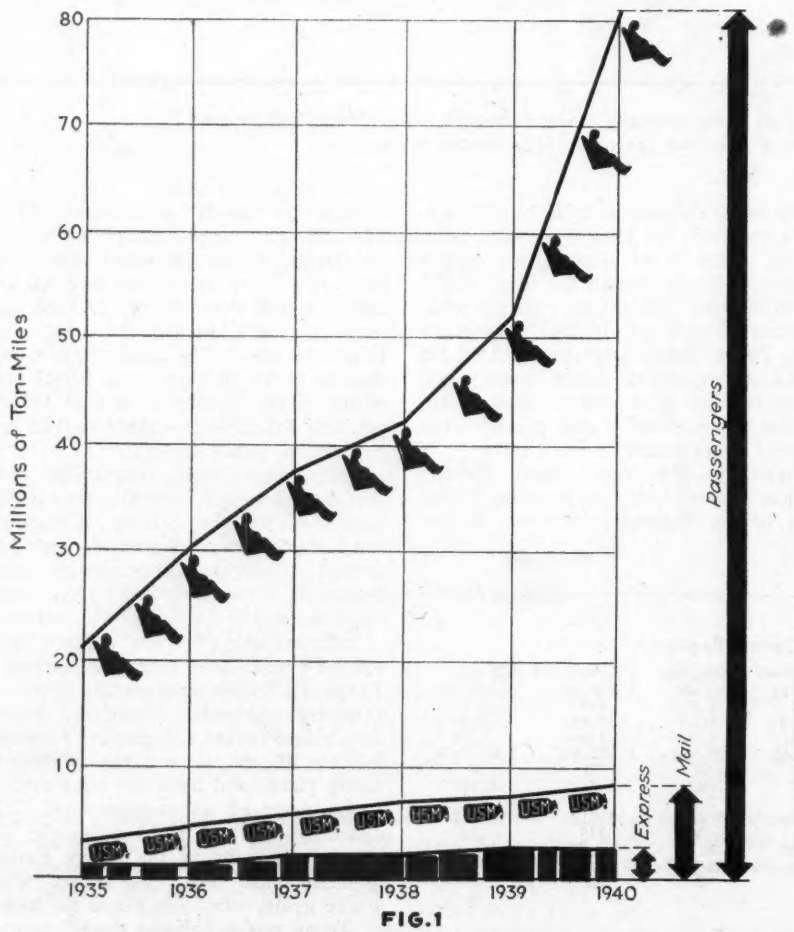


FIG.1

plane now must compete both in time and on the basis of least cost. From the point of view of time utility, the airplane has no competitor.

However, the time element for cargo shipment is least important; dependability, regularity, and cost are more important for the vast majority of shipments. In the matter of competition at least cost, the airplane will become increasingly important. In the long list of commodities requiring transportation there are many which are marginal as to the means of transportation to be selected. With those in which time is not the dominant factor, the airplane will become increasingly important as it is enabled to furnish transportation with diminishing total expenditure of man-hours.

The possibility of the airplane capturing another increment of the available passenger, mail, and cargo market and thereby offering a greater public service depends entirely upon the ability of the commercial airplane manufacturers to produce types which will operate at lower cost. This possibility will be examined on a factual basis, applying the improvements which lie within the realm of engineering possibility. The application of turbo-compressor type engines in combination with propellers will be surveyed. The specifications concerning the engines will be based on calculations according to the best available engineering knowledge.

The power, weight, and fuel consumption characteristics will be attainable according to the present state of the art but will in no sense be representative of any existing propulsive units. This is a necessary stipulation, since all existing or projected types of power plants are classified. Therefore reliance must be placed on theoretical analysis and design.

The Matter of Cost

Money is not an absolute means of measurement of value in the true economic sense. The basic need in order to improve standards of living is to produce more with less expenditure of human energy or man-hours. However, money is so universally used in the calculation of costs, and since it is the medium of exchange which determines profit or loss, further consideration of the problem of costs in these articles will be in dollar units, for domestic operations. It is believed, however, that man-hour equations will eventually be a more fundamental and reliable guide for use in connection with foreign and international markets, since they eliminate the troublesome factors of the fluctuation of money value and rates of exchange.

In normal peacetime commerce there is a tremendous number of passengers, and quantity of mail and express being transported by rail, motor, and by air. An analysis of the trends show that the airplane has become a very important factor in the transportation of passengers, and the increase in passenger business is continuing at a rapid rate. Mail delivery by air is slowly on the increase, whereas express shipments are increasing only at a snail's pace.

The curves of our Fig. 1 show the increase in air travel and shipments of mail from 1935 to 1940 and indicate clearly that the rate of gain in express shipments is not at all in proportion to the spectacular increase in numbers of passengers.

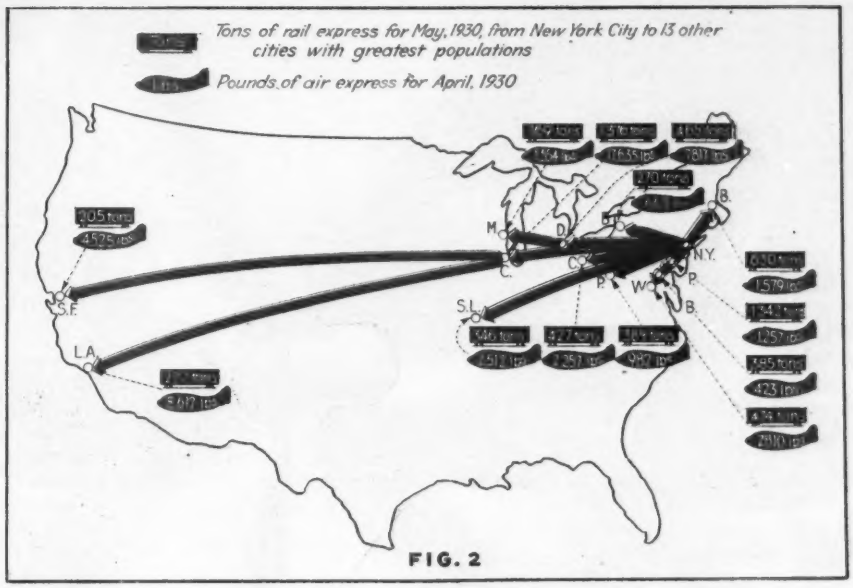


FIG. 2

The potential revenue passenger business on all railroads in the United States during peacetime is approximately 8½ billion passenger miles or about 850 million ton-miles. In 1940 the airplane was serving about 10 percent of the passengers who desired to travel. Mail carried by air in 1939 was approximately 9.8 percent of the total available, whereas the express shipments going by air was insignificant, about .008 percent.

Rapid increase in passenger travel by air apparently shows that safety is no longer a major consideration, since passenger lives are more precious than express packages. It appears that people fly to save time, but that people do not ship by air because cost is more important than time saving.

Fig. 2 shows in graphical form the rail express shipments out of New York City to 13 other large cities during the month of May 1939 in tons, together with the air cargo shipments in Apr. 1939 in pounds. This shows clearly that air cargo is minor in comparison with rail express and that airline companies must be enabled to offer service at lower cost in order to obtain more volume.

Fig. 3 shows the shipments made in 1940 by air, first class rail express, standard rail express, and less-than-carload freight. These are not the total of all shipments, since some 24 billion ton-miles went by truck and about 1.2 billion ton-miles were sent by forwarders. Rail and LCL freight are believed to be most comparable to air cargo transport because

(Turn to page 277)

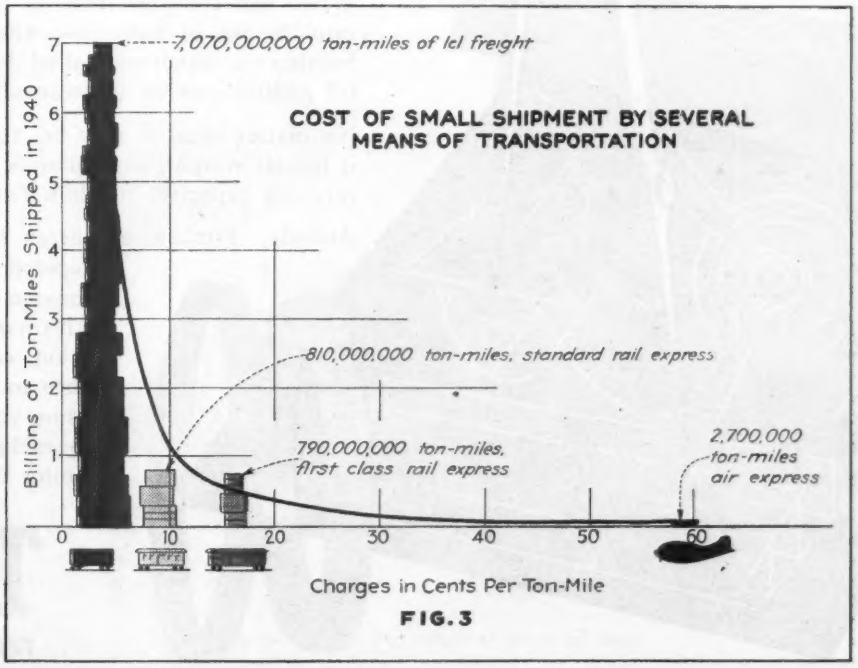


FIG. 3

What'll it be?

When that complex maze of lines on your drawing board soars into the sky of tomorrow what will it be—a deadly fighter or bomber—a touch-controlled helicopter—an enormously powerful airliner—or an undreamed of ship to sail the blue?

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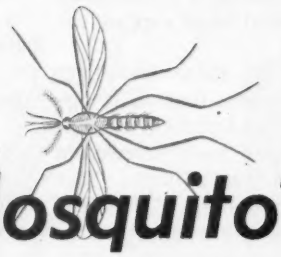
DESIGN ANALYSIS NO. 6



DeHavilland "Mosquito"

PART II

By **CHESTER S. RICKER,** *Aviation's Detroit Editor*

Concluding his outstanding study, the author thoroughly details the landing gear, hydraulic and pneumatic systems, and controls of this remarkable twin-engine bomber.

HAVING DISCUSSED the airframe in detail, we shall now take up the design of the movable parts, such as controls, landing gear and hydraulic and pneumatic pressure systems. First, the controls—

Flaps

Trailing edge flaps are located between the inboard end of the aileron and the fuselage. The flaps are in two sections connected by a torque tube with hinges at each end and in the middle. They are constructed with spruce ribs reinforced with plywood. Finished flaps are covered with a 3-ply skin having the dual grain running longitudinally. The operating jack is attached to the rear spar and moves the flaps by a direct connection at center to the flap operating arm. Control reactions are taken by the rear wing spar almost immediately behind rib 3, where greatest resistance to deflection can be obtained. A rubber tube seal at bottom of the flap prevents any air leakage through the hinge during flight.

Ailerons

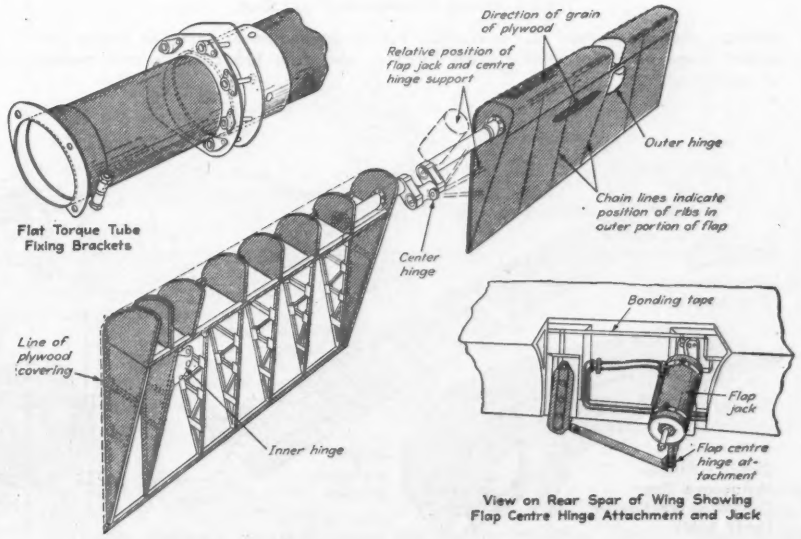
The aileron is built upon 24ST Alclad spar of channel section. The ribs, except those for hinges, are all of skeleton form and made from 24ST Alclad. The entire assembly is covered with 0.012 24ST Alclad skin. The tab, also made from Alcald, is attached at inner end of the aileron by means of a piano hinge. It is automatically operated by an adjustable linkage at the inboard hinge. Mass balances are provided in the leading edge of the aileron. It is supported by three hinges, the outer and inner ones of which are universal so that there can be no misalignment in assembly or in service. Tabs are differentially controlled, the port one being trimmed from the cockpit.

The empennage is quite conventional in general design, but the stabilizer and fin are of wood, while rudder, elevator and trim tabs are aluminum. This group also includes the tail fairings. No outside bracing is used, and all controls are easily reached after removing tail fairings, which are secured with Dzus locks.

Stabilizer

The stabilizer is one-piece all-wood cantilever construction of symmetrical airfoil section. It extends 110 in. each side of the centerline, is 16 in. wide at the tip and about 41 in. at the root. It is supported by two continuous wooden box type spars that run from tip to tip. Except for the center sections, these spars have spruce flanges top and bottom and 3-ply webs on each side. At center the spars are filled with laminated spruce at the point where the front one is attached to the fuselage and where the rear one carries the rigging brackets. There are ten spruce-and-plywood ribs on each side of the stabilizer between spars. A similar number of spruce-and-plywood formers are provided ahead of the front spar for the leading edge.

Small plywood brackets are provided on the back of the rear spar to support the skin where it overhangs. Each half of the stabilizer is covered with 0.16 in. 3-ply birch skins. The leading edge is made from a formed 3-ply spruce member into which the top and bottom skins are fastened and feathered off. Near the center on the forward side of the front spar there are three metal brackets which anchor the tailplane to No. 7, or rear bulkhead of the fuselage. Two brackets bolted to front of the rear spar are connected to the rear bulkhead by two diagonal tubes at each point. These tubes have adjustable clevises at the rear spar


Direction of grain of plywood
Relative position of flap jack and centre hinge support
Outer hinge
Chain lines indicate position of ribs in outer portion of flap
Flat Torque Tube Fixing Brackets
Center hinge
Bonding tape
Line of plywood covering
Flap jack
Inner hinge
Flap centre hinge attachment
View on Rear Spar of Wing Showing Flap Centre Hinge Attachment and Jack

Wing flap construction and details of operating jack.

brackets so that incidence of the stabilizer can be adjusted when rigging the ship.

Construction of these stabilizer brackets is very interesting. Fittings attached to the rear bulkhead to support the front spar have screwed-in bushings which may be adjusted about 1/16 in. in either direction. Thus it is easy to correct for slight variations in dimensions when assembling the stabilizer on the fuselage. To make an absolutely tight fit between fuselage bracket and front spar bracket which straddles it, a split bushing instead of a bolt is used. Each end of this bushing is bored out on a taper into which cones are inserted with a bolt so they can be drawn together to expand the split bushing. A castelated nut and cotter key secure the bolt when the bushing is tight.

At top and bottom of the rear fuselage bulkhead there are brackets to which the rear spar diagonal braces are attached. One through-bolt holds both in place. At rear spar brackets, the bracing tubes are attached with clevises, which have screw and lock nut adjustments to permit adjusting incidence of the stabilizer. This adjustment varies through angularity, so it is necessary to connect the clevises to the bracket proper through links pivoted on a horizontal pin. Thus no bending strains are introduced either in the tubes or on the threaded portion of the clevises.

What does not show in the drawings but is an important part of the support, are the longitudinal laminated spruce reinforcements which transfer loads from the rear spar brace brackets on No. 7 rear bulkhead to the fuselage floor and to No. 6 bulkhead. Metal angles backing up the brackets are fastened to these reinforcing members, thus the stabilizer forces are absorbed by both No. 7 and No. 6 bulkheads, as well as the monocoque structure enclosing them.

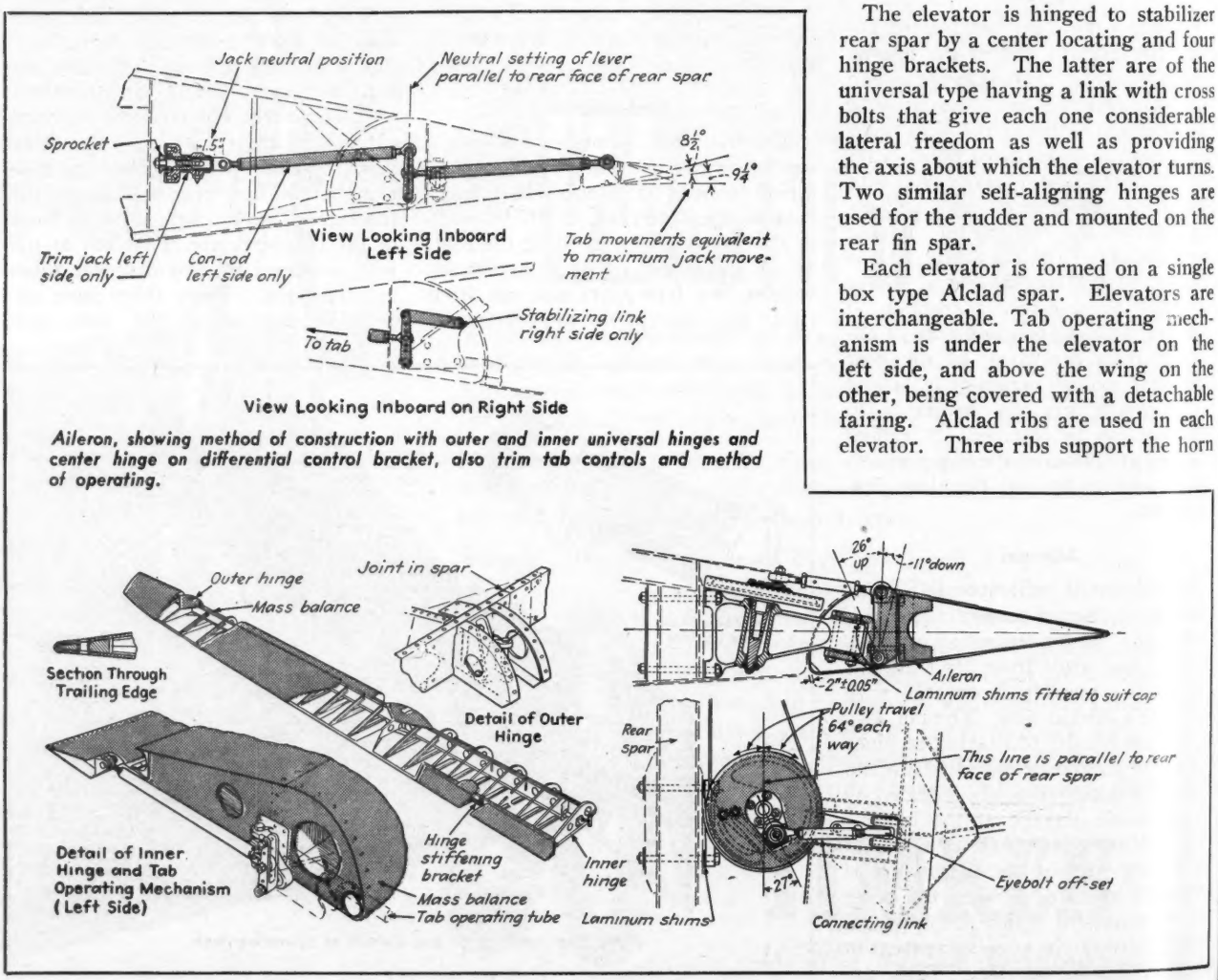
The stabilizer spars taper from center to tip, varying from about 7.25 in. maximum height at center to about 4 in. at the tip. In width they are also tapered from 2.25 in. at center to 1.25 in. at tip. The rear spar is straight, but the front has a sweep back on each side of about 1 in. in 4. The spar booms are formed from six laminations of 0.4 in. spruce and built up of selected long grain pieces. The front flanges are tied together with 0.16 in. 3-ply webs, the rear flanges by 0.12 in. 3-ply webs on each side. The inside of the spars is filled with 5-ply spruce blocks wherever a bracket is attached. The attachment points are armored on the outside with compressed 0.5 in. plywood. There are six of these points on the rear spar, two at the center, two at the ends, and two for the intermediate hinge brackets. At every rib point there are 0.5 in. wide and 0.4 in. thick vertical spruce stiffeners to which the leading edge, intermediate ribs, and trailing edge ribs are glued and screwed.

The stabilizer tip rib and the rib at the inside edge of each section have solid 3-ply sides that act as a closure. All the other rib units are of one-sided plywood construction. There are also two heavy box section ribs 1 in. wide and about 7 in. high near the brackets which support the stabilizer and act as compression spacing members between front and rear spars. They are bolted through metal angle plates to both spars and brackets and bear against compressed plywood facing on spars.

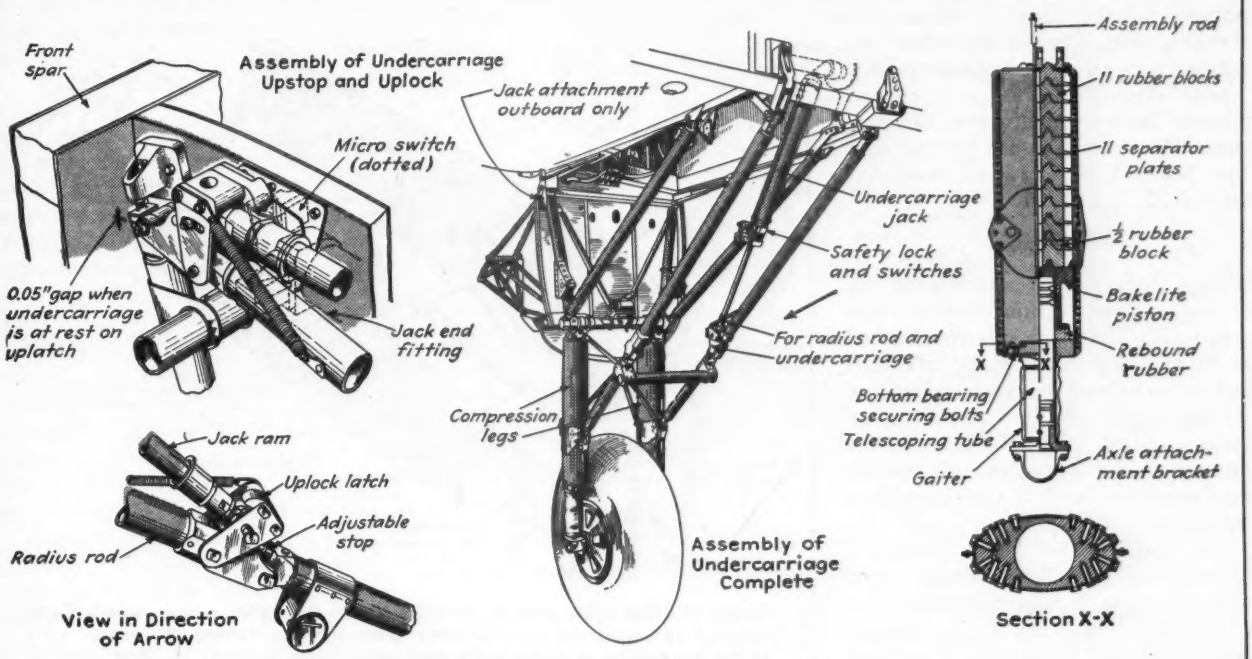
Elevators

The elevator is hinged to stabilizer rear spar by a center locating and four hinge brackets. The latter are of the universal type having a link with cross bolts that give each one considerable lateral freedom as well as providing the axis about which the elevator turns. Two similar self-aligning hinges are used for the rudder and mounted on the rear fin spar.

Each elevator is formed on a single box type Alclad spar. Elevators are interchangeable. Tab operating mechanism is under the elevator on the left side, and above the wing on the other, being covered with a detachable fairing. Alclad ribs are used in each elevator. Three ribs support the horn



Aileron, showing method of construction with outer and inner universal hinges and center hinge on differential control bracket, also trim tab controls and method of operating.



Landing gear with details of lock, hydraulic jack, and compression strut. Micro switch is attached to side member of frame.

and six carry the tab. Second and third ribs from the inner end are closer together and straddle the tab operating rod. This prevents deflection at this point, assures uniform action in tab control, and provides secure anchorage for the elevator torque tube. Elevators are bolted together at the center hinge fitting.

To the port elevator torque tube flange are bolted the elevator operating arms, to which the operating cables are attached. These pass over ball bearing sheaves on the aft side of stabilizer front spar and through rear bulkhead into fuselage. To the starboard elevator a static balance weight arm is bolted. Mass balance weights are also provided inside the aerodynamic horn balance at outboard end of each elevator. The elevator torque tube extends through the two inboard ribs of each elevator and is riveted to them.

Elevator tabs are located between the inboard end of each elevator and the 6th rib from center. An Alclad channel spar connects the rear ends of these ribs and has a piano type tab hinge along its lower flange. The port tab can be used for trimming and can be adjusted 8½ deg. up to 9¼ deg. down by the cockpit tab trim control. Adjustment is obtained by a screw trimming jack, located at elevator center bearing and bolted to back of the tailplane rear spar.

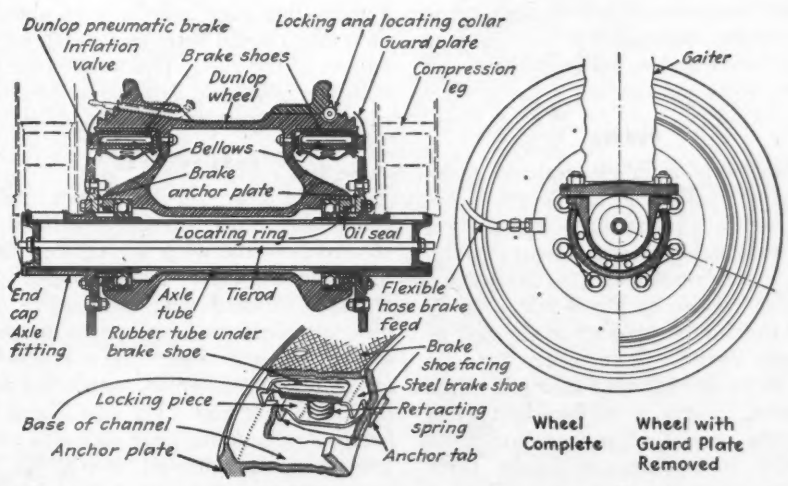
The trim control operates through a box-like member bolted to the left trim tab tube. A nut running on a vertical screw changes the tab position and is turned by a small chain sprocket at the top, which is controlled by a chain and two elevator trimming cables leading from the cockpit. Sprocket and cables are in a sheet aluminum housing to protect them from water or mud.

Elevator construction follows conventional practice. Forward edge has a 2.75 in. radius skin with a 5.12 x 0.75 in. channel main spar riveted inside, to which channel section ribs are attached. Aft inner corner of the elevator is braced by a diagonal tube. The ribs all have lightening holes and

Landing Gear Data

Type—Two retractable single wheel units with two rubber shock absorber struts to a unit.

Wheel material (all wheels)	Magnesium
Wheel base	342.875 in.
Tread	196.0 in.
Main gear compression leg travel total	5.5 in.
Tail wheel	Swivel type, retractable
Main wheel dia.	16 in.
Tail wheel tire dia. (dual tread)	17.5 in.
Main wheel tire (Dunlop)	15.00 x 16 in.
Tail wheel tire	8.00 x 5 in.



Section through landing wheel showing arrangement of twin pneumatic brakes mounted on hollow axle. Brake anchor plates on each side of wheel inclose braking surfaces and transmit brake torque to axle and struts. Detail gives method of holding brakes in position.

"Z" section stiffeners are used top and bottom on the skins between ribs. Trailing and elevator tip edges are formed with an oval aluminum tube to which skins are fitted and riveted. Brazier head rivets are used throughout. The under skin and trailing edge are fastened by 0.12 in. explosive rivets.

Tail Fin

The single fin is attached to top of the fuselage by four brackets and four bolts. These brackets are attached to the two rearmost fuselage bulkheads and project above the fuselage skin. A fairing covers bolts and brackets after fin is installed. As will be noted, the fin and rudder loads are well distributed over rear end of the monocoque structure.

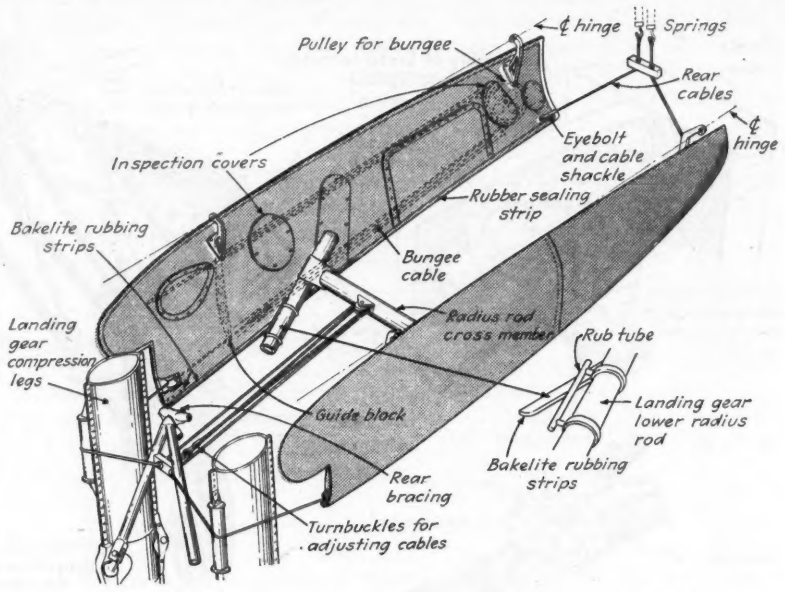
Fin spars are of heavy laminated construction with 3-ply spruce webs. The rear spar is approximately 7 in. wide and 2.5 in. thick at the bottom, tapering to 0.87 in. at top. The front spar tapers from 2.12 to 1 in. Front and back these spars have "H" shaped laminated steel brackets bolted to the bottom ends. The inner lamination runs about 13 in. up the spar. These metal brackets straddle the metal ones, which strengthen the fuselage bulkhead extensions that project through top fuselage skin. Brackets on the bottom of the two fin spars are 21.5 in. apart on centers. To give lateral stiffness to the fin, bolt holes at rear bracket are spaced 2.87 in. each side of centerline. Two 0.75 in. bolts are used to hold the rear spar; two 0.62 in. to secure front spar of the fin. Leading edge of the fin is a 3-ply formed spruce member into which the skin is faired.

The three rudder hinge brackets are bolted to aft side of fin rear spar. Where brackets are bolted, Bakelite or compressed laminated wood is used as a bearing for both brackets and bolts.

Rudder

Rudder is a fabric covered metal structure, while the tab is all Alclad attached by a piano hinge on the right side to metal rear spar of the rudder, and extending upward from bottom edge of rudder to No. 4 rib. Tab is used to trim the rudder but also acts as a servo device. It furnishes the trim and servo deflections to the left, while a spring moves it to the right (this is fully explained under controls). Rudder is fastened to fin by three hinges along the rear spar. Bottom hinge of the rudder and center hinge of the elevator are arranged to take both radial and end loads. That is why all the other hinges can be universal jointed Eleven hinges have ball bearings and are packed in non-freezing grease.

The rudder is built like the elevator with an Alclad box spar consisting of the semi-circular hinge portion with a channel spar riveted between the open ends. There are eleven metal ribs, three of which form the rudder horn and carry the mass balance weight. Five bottom ribs support rear spar and tab. Tab mechanism is between ribs 2 and 3, which are close together as on elevator. Rudder lower corner is braced by a diagonal tubular strut attached to torque tube under rib 2. There is a diagonal tubular brace from rib 5 at the hinge spar to trailing edge. The trailing edge is a flattened aluminum tube riveted between trailing edge flanges of the ribs. The torque tube is bolted to ribs 1 and 2 of the rudder and carries tab operating tube inside it.



Bungee in wheel doors provides force for closing them when gear is raised. Cable attached to radius rod cross member gives sufficient tension to bungee, while rollers on outside of compression legs moves cable outwards to cause doors to open. Bakelite rubbing strips on radius rods prevent wear on members.

Landing Gear

Landing gear consists of two interchangeable units attached by tubular structures to the wing immediately behind the engines. Two brackets on front of forward wing spar serve as pick-up points for both engine mounting and undercarriage. These brackets are bolted to companion angles that tie the front spar and wing ribs 3 and 4 together. Landing gear supports extend downward behind firewall to a horizontal tube that serves as a hinge point for landing gear. This upper structure is braced laterally by diagonal tubes and longitudinally by heavy tubes which terminate in brakets on the rear portion of wing ribs 3 and 4, forming fixed portion of the support.

Movable parts of landing gear consist of oval steel-tube compression struts hinged on fixed horizontal tube. At bottom they are secured to the axle with forged steel "U" straps. Legs are cross-braced by tubular members diagonally arranged and are held in place by radius rods that are attached to rear of legs and to rear wing spar. A double acting hydraulic jack raises or lowers the gear.

Each landing gear unit is provided with doors that close automatically as the unit is retracted into the wheel bay. A latch mechanism on the right hand radius rod holds gear in up position. Down position is secured by a spring-loaded mechanical safety latch incorporated in the lower fitting on hydraulic jack cylinder. It engages in a collar on the jack ram and is released only by hydraulic pressure on the safety valve when raising undercarriage.

Bottom sections of the right and left-hand hinged radius rods are joined together at their upper ends by a large tube and forged fittings. Since the hydraulic jack in only attached to the right hand radius rod, the cross tube must carry load due to lifting the left hand radius rod.

A visual indicator in the cockpit shows when undercarriage and tail wheel are locked in up or down position, and a warning horn will sound when landing gear is not locked down and throttles are more than three-quarters closed.

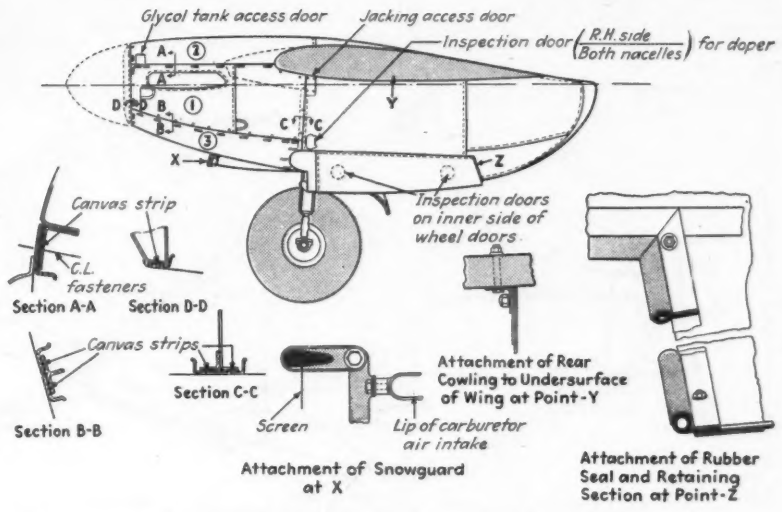
Two micro switches on the landing gear operate visual indicators; the up switch is just above the up latch bracket on right wing rib and operates when latch has engaged the uplock—the down switch is on the undercarriage jack cylinder. A Graviner gravity type is used. A second switch is introduced in the circuit so that the gravity switch can be rendered operative when the wheels are down and inoperative when they are up. This is necessary to prevent the fire extinguisher from functioning during aerobatics.

Shock Absorber Strut

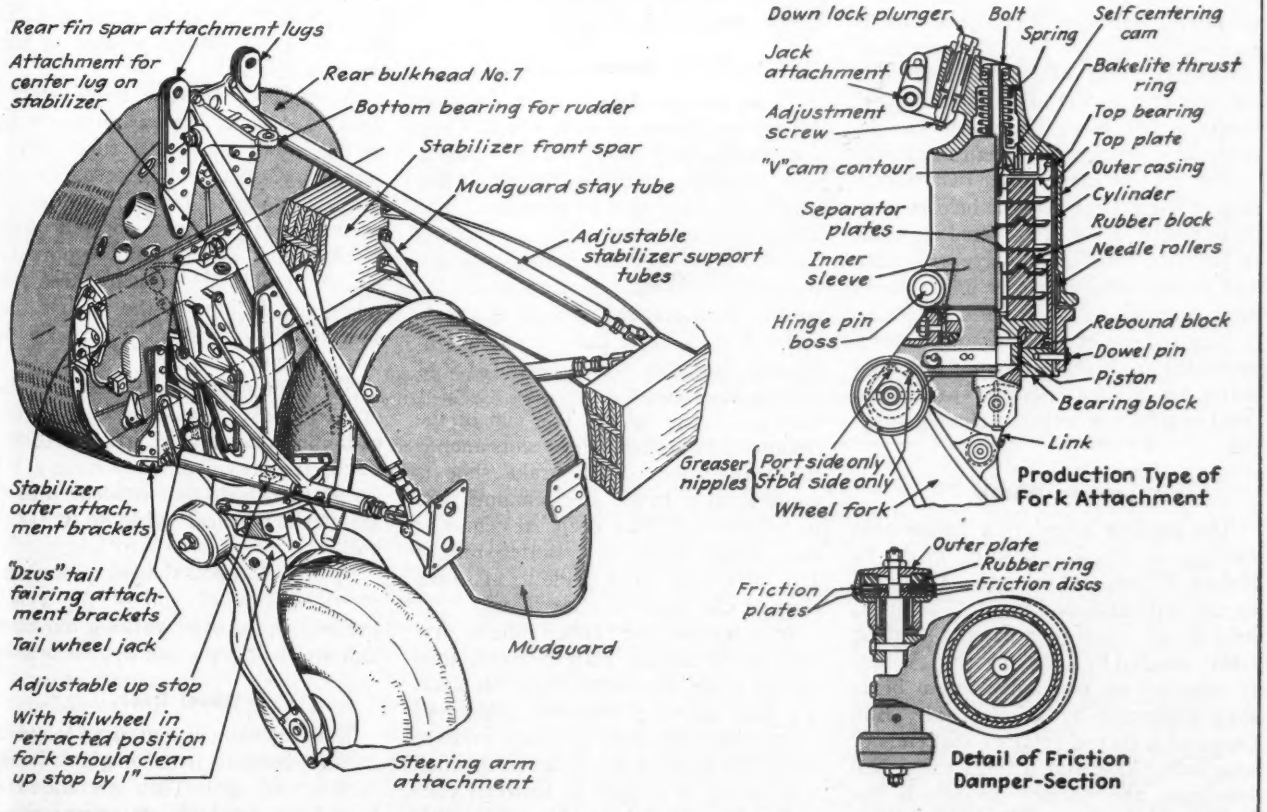
Two shock absorber struts are compression rubber type and are oval in section, made from 8-ga. steel stampings. The upper head carries a bracket that is hinged to the stationary landing gear frame. The lower or open end of the tube is closed by a fabric and Bakelite molded head which guides the tubular piston rod. An oval Bakelite piston slides up and down inside the tube.

Between head of strut tube and piston are nested eleven rubber compression blocks, separated by aluminum guide plates. The blocks are smaller in section than the tube to allow for expansion. There are eleven blocks of full thickness and one of half thickness all located above the piston and also one block beneath the piston to absorb rebound. Each block is molded with two conical projections on top and corresponding depressions in the bottom to keep blocks and plates in alignment. The piston tube is attached to the Bakelite piston by scrivets and threaded rods. Where the piston rod passes through the Bakelite guide, the bore is lubricated with graphite. Bottom end of the piston tube carries a rectangular forged flange to which the wheel axle is attached by a forged steel U-shaped strap and four bolts.

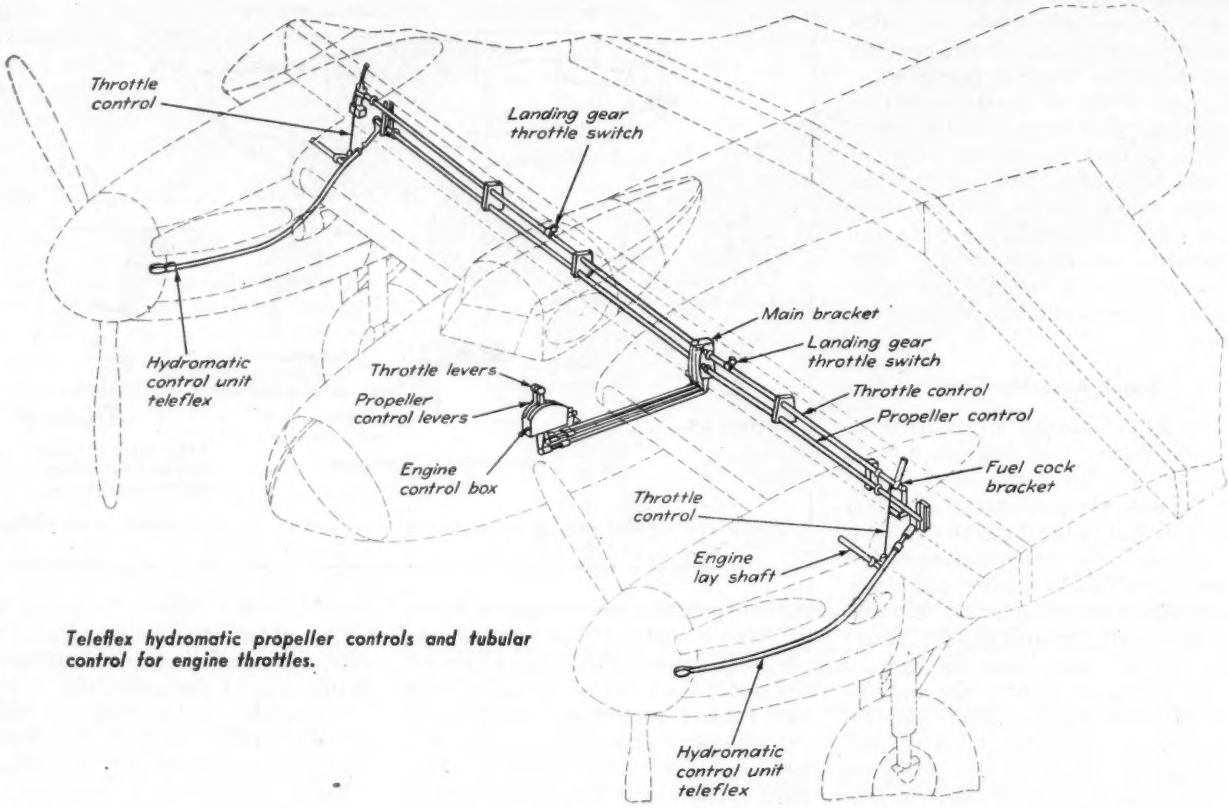
Since there is no hydraulic or pneumatic mechanism in the strut to


Glycol tank access door
Jacking access door
Inspection door (R.H. side / Both nacelles) for doper
Canvas strip
C.L. fasteners
Section A-A
Section D-D
Inspection doors on inner side of wheel doors
Canvas strips
Section C-C
Section B-B
Attachment of Rear Cowling to Undersurface of Wing at Point-Y
Screen
Lip of carburetor air intake
Attachment of Snowguard at X
Attachment of Rubber Seal and Retaining Section at Point-Z

Engine cowling and nacelle in relation to wing section, showing methods of attaching.



Dual-tread tire, friction dampeners, and centering cam make high speed landings possible with this tail wheel. Rubber shock absorber takes stresses from framework. Fin spar is supported by laminated steel lugs at top of bulkhead.



Teleflex hydromatic propeller controls and tubular control for engine throttles.

leak, it can be made without recourse to micro finishes. No adjustment is required in service beyond renewal of compression and rebound rubbers after considerable service. For small adjustments a full block of rubber can be substituted for the one of half thickness.

The tube is made from two stampings of 8-ga. steel that are held to very close limits. They are riveted together in pairs to form a complete oval tube and do not require further finish inside after assembly.

Exposed end of the piston rod is fully protected from the elements, dirt, and water by a boot attached to bottom head of tube and axle attachment forging.

Landing Wheels

The landing wheel is a magnesium casting of Dunlop design, made by Kelsey Wheel, and mounts a 15.00x16-in. tire with anti-skid tread. The tire is held on the wheel by a flanged locating collar secured by a locking ring. Wheel is mounted on two anti-friction bearings supported by tubular axle. End caps and a tie rod retainer seal ends of axle tube. Axle end fittings carry ball bearings, are flanged to attach the brake anchor plates. The hub of these fittings has a flat upper surface with a spigot to lock and pilot the shock absorbed strut bottom. Through this the braking torque is transferred to the shock absorber unit.

Brakes

There are two 13 x 3,25 in. internal expanding brakes in each wheel. They are pneumatically operated by a rubber tube located just under the six brake shoes in each brake assembly. The brake anchor plate has a channel shaped rim which extends inward beneath the braking surface of the wheel. This channel is 3.37 in. wide and 0.5 in. deep. It has 1.5 in. slots at 60 deg. intervals, which are located at each side of the channel and go clear through to the inside. The rim of the channel is unbroken. These slots anchor the brake shoes. Each brake shoe is made from a 16-ga. steel channel 3.25 in. wide and 0.37 in. deep. At center of each flange there is a slotted tongue 1 in. deep and 1.5 in. wide to fit in the slots of the brake anchor plate.

In assembly, the rubber tube is first laid in the anchor plate channel, then the six brake shoes are slipped in place. To hold them, a retainer yoke goes across between slots in lower ends of the brake shoe anchor tongues. A small coil spring is slipped in between yoke and underside of the anchor plate. This not only locks the brake shoe in place but draws it down tightly against the anchor plate channel and prevents it dragging when brake is released. The individual brake shoes have a 3.25 x 0.25 in. brake lining riveted to their working face.

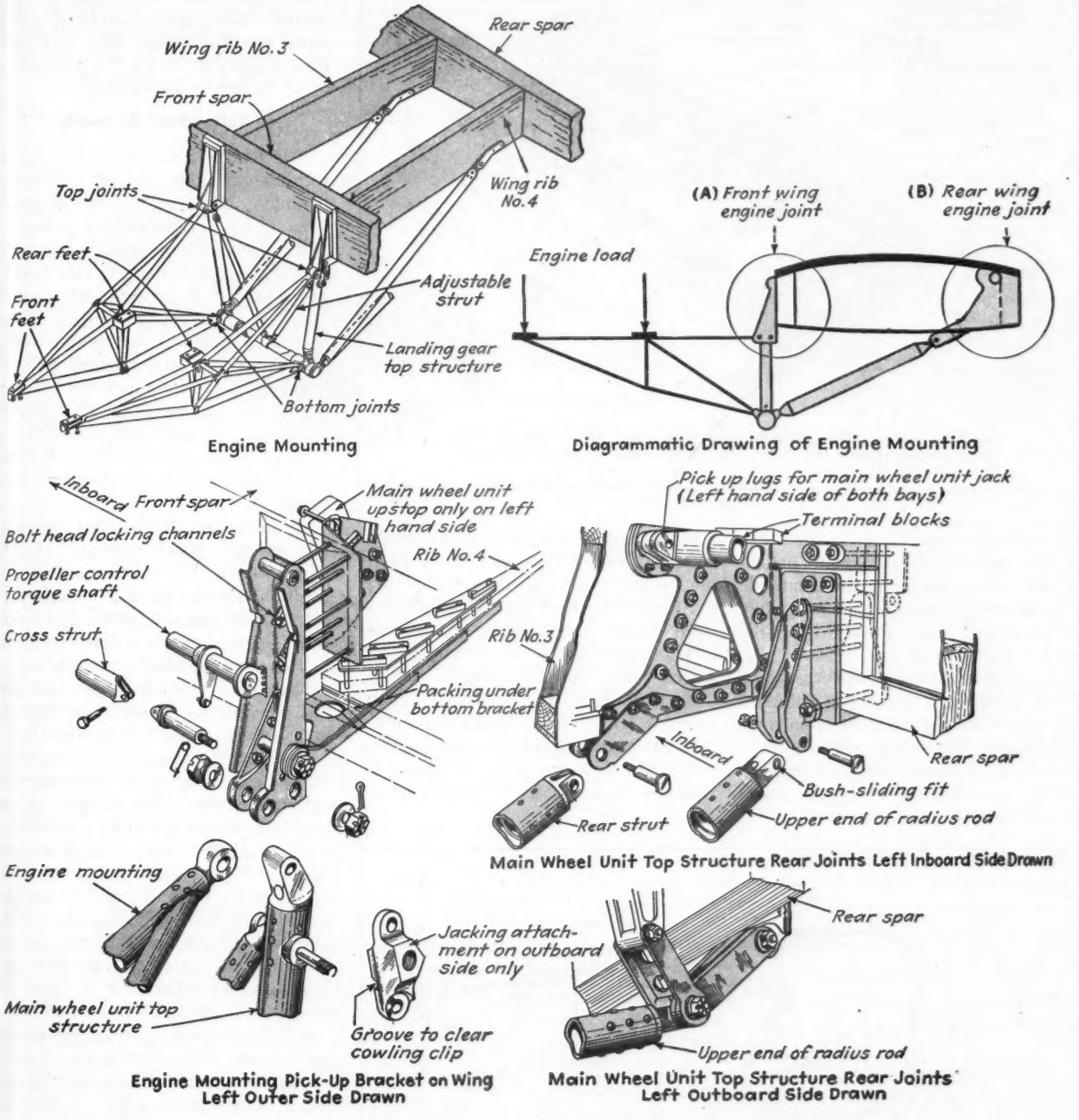
A regular tire tube angle stem is used to connect the air pressure line to the brake expanding tube. This is stationary, so after it passes through the brake anchor plate it can be connected directly to the air pressure tubes fixed to the side of the compression leg. A flexible air pressure hose joins tubes and fitting on the anchor plate so as to allow for shock absorber action of the compression leg.

Since the magnesium wheel does not of itself make a good braking surface, cadmium plated steel inserts, 0.18-in. thick, are provided. They have a 1 in. lip on the inside that is secured to the magnesium wheel with 16 0.312 in. bolts.

Spring closed L-shaped oil seals are provided at each end of the axle to prevent any grease working out of the hub and being thrown on the brakes.

Wheel Doors

Wheel doors are contoured to enclose nacelle bottom from engine firewall back to rear spar. They are made from two sheet aluminum stampings riveted together along the edges, and there is a stiffening rib at the front hinge section. Each is supported by two invisible


Rear spar
Wing rib No. 3
Front spar
Top joints
Wing rib No. 4
Rear feet
Front feet
Adjustable strut
Landing gear top structure
Bottom joints
(A) Front wing engine joint
(B) Rear wing engine joint
Engine load
Engine Mounting
Diagrammatic Drawing of Engine Mounting
Inboard
Front spar
Main wheel unit upstop only on left hand side
Bolt head locking channels
Rib No. 4
Propeller control torque shaft
Cross strut
Rib No. 3
Packing under bottom bracket
Pick up lugs for main wheel unit jack (Left hand side of both bays)
Terminal blocks
Inboard
Rear spar
Bush-sliding fit
Rear strut
Upper end of radius rod
Main Wheel Unit Top Structure Rear Joints Left Inboard Side Drawn
Engine mounting
Main wheel unit top structure
Jacking attachment on outboard side only
Groove to clear cowling clip
Rear spar
Upper end of radius rod
Engine Mounting Pick-Up Bracket on Wing Left Outer Side Drawn
Main Wheel Unit Top Structure Rear Joints Left Outboard Side Drawn

Engine and landing gear supports form a light, rigid frame, bolted through spars and ribs to spread load and stresses through the structure.

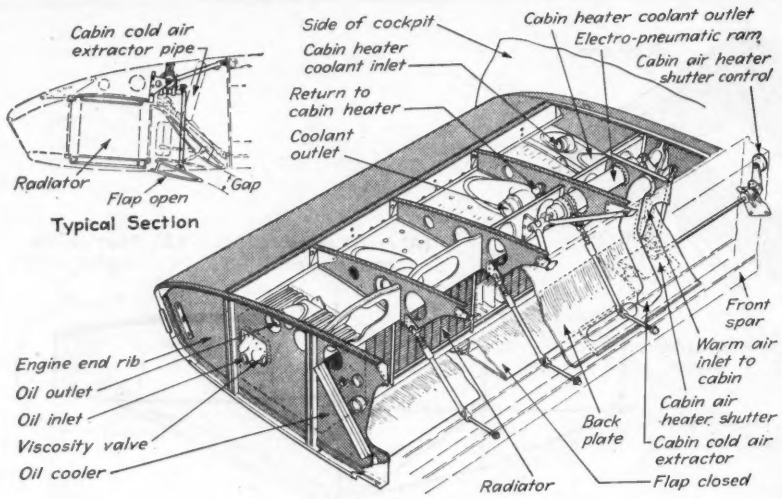
type hinge brackets. The lower edges have a 0.5 in. rubber tube to provide a seal. Front and rear ends fit over canvas sealing pads riveted to nacelle panels.

Operation of the doors is perhaps the most interesting feature of the assembly. The rear ends are drawn together by spring-loaded 0.18-in. flexible steel cables and are opened by tubular steel guards attached to the undercarriage legs as landing wheel is lowered. After legs clear ends of the doors, tubes attached to sides of lower radius rods catch Bakelite rubbing strips on bottom edge of doors and keep them apart.

To pull the doors together, 0.18 in. flexible steel cables are used. These are attached through turnbuckle adjustments to the cross piece between diagonal leg cross braces. They are then led back to a pair of pulleys on the radius rod cross member tube and forward again through bronze fairleads in the cross piece to which the ends are first attached. From the fairleads the cables pass over long Bakelite rollers attached to front of the compression legs and thence into front end of the wheel doors guided between a couple of plastic sheaves.

End of the cable is attached by eye splices to the end of a $\frac{3}{8}$ in. "bungee," which is led around a pulley at rear of each wheel door and back to the front end of that door. When doors are open, the "bungee" is stretched almost double its original length. This structure permits keeping the doors under tension at all times, whether open or closed.

The hydraulic system used for operating the landing gear contains two independent circuits—one the regular, the other an emergency system. Two hydraulic pumps are used, one on each engine. A hydraulic accumulator is provided in the aft part of the fuselage between bulkheads 3 and 4. Lines from

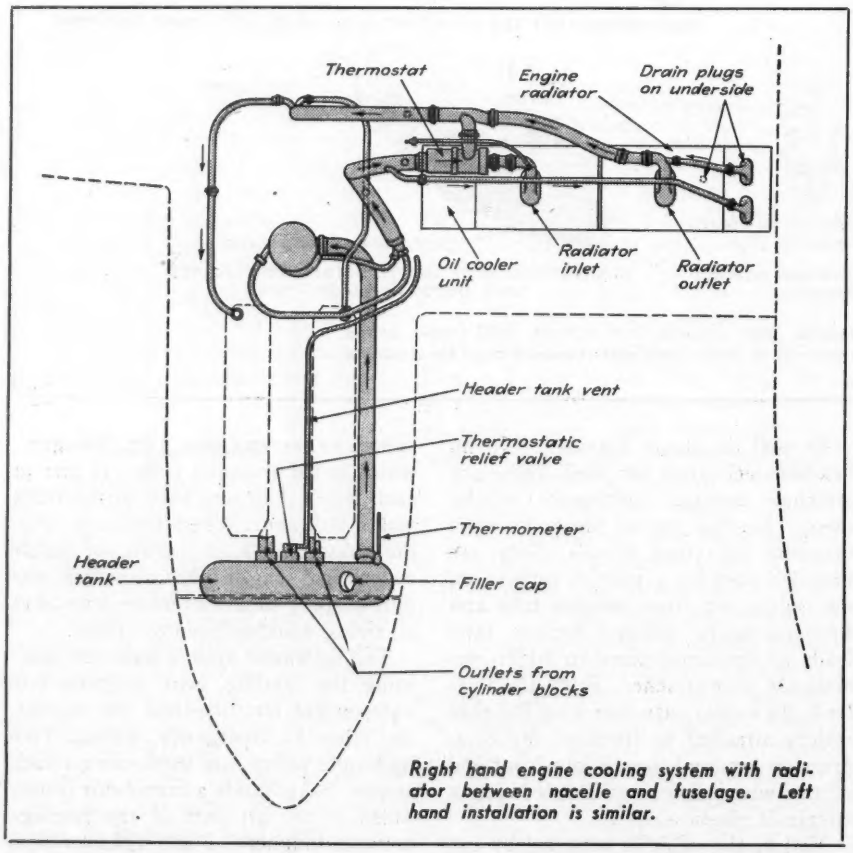


Cooling unit in three sections, seen from rear. Oil cooler at left; engine radiator on right. Cabin heater is heated by radiator coolant.

engines to junction block in the cockpit, and from selector valve to undercarriage jacks, run along the front side of main wing front spar, where they are accessible when fairing over the radiator is removed.

The emergency undercarriage "down" line runs along aft side of main wing rear spar. Hence if the front lines are damaged it is still possible to lower the wheels. A hand pump can be used for this purpose if engine pumps are not working. Emergency selector valve just behind pilot's seat cuts in emergency line. This line does not connect with the tail wheel, and the ship has to land without it being lowered; but the damage sustained would be minor compared with a "belly landing."

Undercarriage and tail wheel selector lever is center in the hydraulic control box in cockpit. A safety catch must be released before the up position can be selected. Selector lever should return automatically to neutral when up or down operation is completed. If it should return prematurely, it is put down again by hand. This is possible in cold weather due to the greater viscosity of the hydraulic fluid.



Right hand engine cooling system with radiator between nacelle and fuselage. Left hand installation is similar.

Tail Wheel Assembly

The 8.00 x 5 in. rail wheel is on a retractable unit having a vertical trunnion. Like the undercarriage legs it has rubber type shock absorber. The wheel is mounted on a hinged fork attached to a caster swivel. Load is transmitted from hinged fork to rubber elements in swivel cylinder by link and piston rod. Shock absorbing elements are carried in a steel cylinder on needle bearings inside the shock absorber casing on the rear fuselage bulkhead. The jack ram is connected to the casing through a link which retracts the locking pin before it starts to raise the tail wheel.

A micro switch operated through a flat spring, which contacts the tail wheel casing when it is in the down position, closes the circuit to the indicator on instrument panel. No indication is provided when the wheel is up.

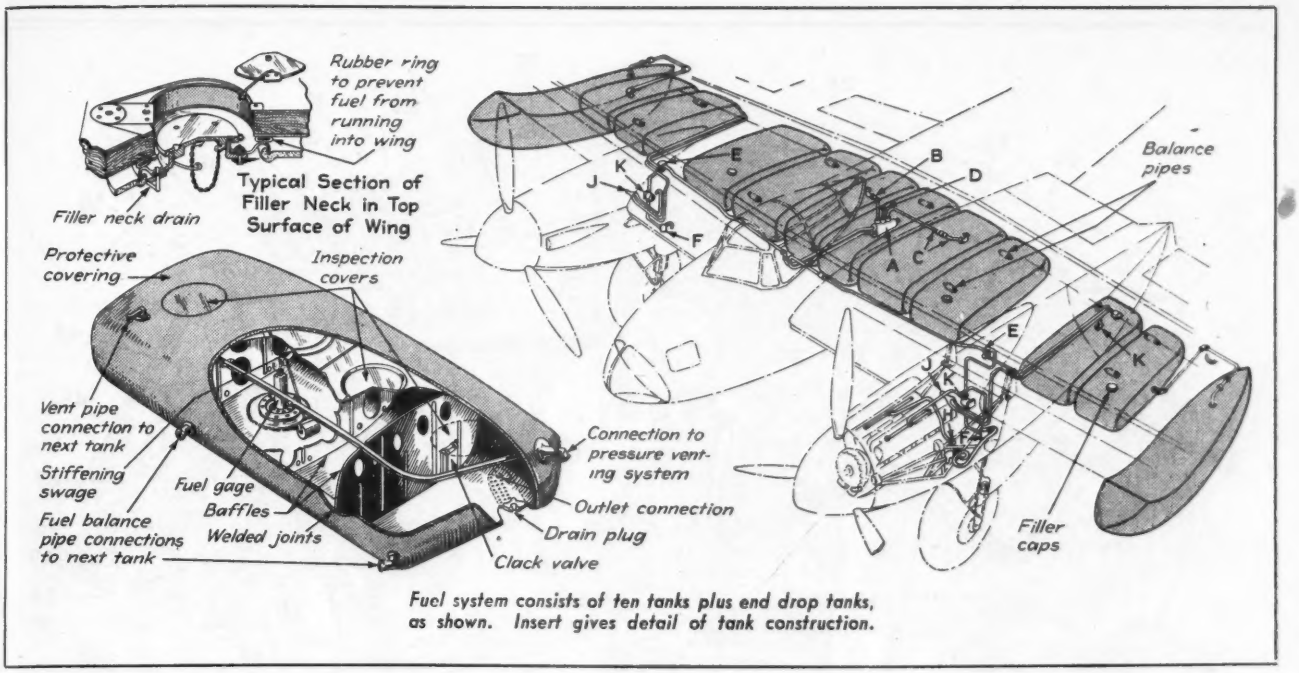
The shock absorbing unit has six rubber blocks for cushioning purposes and one between shock absorber piston and bearing block to take rebound.

The outer casing is a magnesium casting in which the shock absorber cylinder rotates. The cylinder is supported at the head end by a plain bearing and at the lower end by a needle roller bearing so there is no wear on the softer magnesium. The top plate or cylinder head bears against a Bakelite thrust ring when the shock absorber is in action. This top plate carries a V-shaped centering cam. Another cam that does not rotate is located in the head of the casing and spring pressed against the V-cam on the cylinder to center the tail wheel in flight. The cylinder is held in place by a hollow bolt through the center and supported by a ball thrust bearing.

The shock absorber piston is guided by a bearing block inserted at bottom end of the cylinder. The method of locking the fork attachment to it with dowel pins is interesting. These pins are held in place by a band with notched holes that slip into a grove under the head of each dowel pin.

Cylinder and inner sleeve are fastened to the fork attachment by counter-sunk bolts.

Adjustable friction disk vibration dampeners are applied to the hinge shaft of the fork attachment. A rubber compression ring is used to adjust their tension. Tail wheel assembly on the rear bulkhead is pivoted on two bearings located as far apart as possible



Fuel system consists of ten tanks plus end drop tanks, as shown. Insert gives detail of tank construction.

and supported by a tube. This tube prevents their binding under severe twists. Laminum shims in the supporting bracket bushings permit axial adjustment of the tail wheel assembly so the locking pin will align with the locking ring in the rear bulkhead.

The combination of self-centering cam friction shock absorbers and dual-tread tail wheel provides an unusually safe and satisfactory tail wheel action during high speed landings, according to the designers.

Engine Cowling

Engine cowling, nacelle, and wheel doors form a streamlined unit that is beautifully faired into the main wing when the ship is in flight. Dzus fasteners are used to hold the engine cowlings in place. All joints are made practically air tight, either with tubular rubber or canvas seals.

Engine Controls

Throttle and propellor controls are mechanically operated from the cockpit through levers and ball bearing torque tubes attached by brackets to the front wing spar. Cams on throttle torque tubes operate undercarriage warning lamps and horn switches when the throttles are more than three-quarters closed.

Two-speed supercharger on each machine is controlled by an electro-pneumatic ram. With cockpit switch set at *Auto* an aneroid operated switch will bring the supercharger into operation at 15,250 ft. altitude. If the switch is set at *Mod.* (moderate) only single-speed supercharging will be obtained at all altitudes. Flexible cables from cockpit to engines cut out "slow running" and "automatic boost" controls when required in emergencies. Additional electro-pneumatic air intake controls are provided for tropical operation.

Mounting

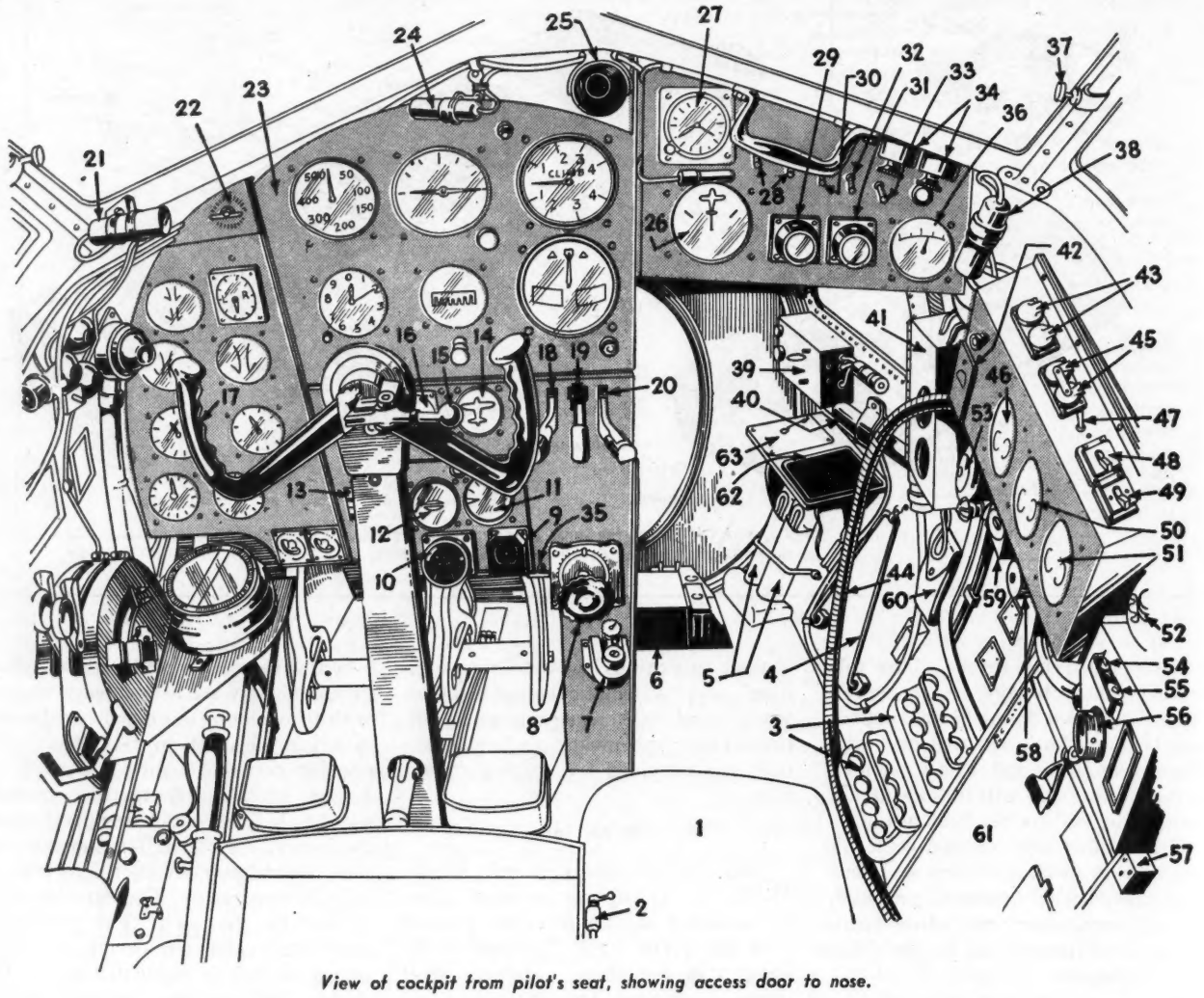
Two Packard-Rolls Royce *Merlin* 31, 33, or 225 engines are used. They are mounted on four feet cast integral with the crank case. To support the engines in the plane, a tubular steel frame is provided. This consists of two units, one left and the other right, which are attached to brackets bolted to the front of the front spar. Ribs 3 and 4, immediately behind these brackets, give them the necessary torsional rigidity. The interesting feature of this structure is combination of engine mounting frames with fixed undercarriage tubular members. This makes an inverted bridge truss that not only supports the engine but strengthens the landing gear. The construction transmits the engine inertia loads directly to the undercarriage when landing instead of through the wing structure.

To take engine torque and provide lateral stability for the engine, transverse and diagonal bracing is incorporated in each mount. Construction of the spar attachment brackets for undercarriage and engine are of unusual interest. Ordinarily it is quite a difficult problem to make transition from metal to wood, but the problem is handled in a very direct and simple manner in this case. Even the flap jack and center hinge support are tied into this structure to get maximum bracing.

Sixteen gallons of water and ethylene glycol mixture are used in each engine, with provision of an expansion header tank just ahead of the cylinders. Filler opening for the cooling system is in header tank. A thermometer is provided to indicate engine temperature on the instrument panel. Thermostats and movable radiator air duct flaps control engine temperature. The flaps are controlled by the pilot. The automatic thermostat valves are designed so only jacket coolant is circulated up to 185 deg. F. This provides a quick warm-up. Above 221 deg. F. all coolant circulates through the radiators. Each engine has its own cooling system for both coolant and lubricating oil. The connections are short and direct from engine to radiator core.

Radiator is located on front spar between fuselage and engine nacelle. The air duct forms leading edge at this point. Radiator unit cover forms the top of the wing, and the same is true of the bottom. The radiator cores are mounted in an aluminum frame structure that is bolted to the front of the main wing spar. The lower connections are tubular in form, provided with a screw adjustment for length. The top is attached to the wing spar by the five channel shaped ribs which go over the top of the radiator cores. These ribs have lightening holes through which the service pipes are threaded. Diagonal tubular braces at center steady the whole installation laterally. They also take reactions from the electro-pneumatic ram which operates the cooling flaps in the air outlet stream.

Air enters the radiator duct through



View of cockpit from pilot's seat, showing access door to nose.

1. Front entrance door.
2. Harness release lever.
3. Very light cartridges.
4. Syko storage.
5. Portable oxygen bottles.
6. Bombsight base.
7. Deicing hand pump.
8. Aileron lateral trim control.
9. Aileron trim indicator.
10. Brake pressure gage.
11. Oxygen contents gage.
12. Oxygen flow indicator.
13. Master switch.
14. Flap and undercarriage indicator.
15. Brake lever.
16. Undercarriage position indicator.
17. Handwheel.
18. Bomb door control lever.
19. Undercarriage and tail wheel control.
20. Flap control lever.
21. Lamp.
22. Automatic boost cutout control.
23. Blind flying instrument panel.
24. Lamp.
25. Ventilator.
26. Visual indicator.
27. Time of flight clock.
28. Radiator flap switches.
29. Feathering control switch—left.
30. Navigation lamp switch.
31. Feathering control switch—right.
32. Fuel pump switch.
33. Pilot head switch.
34. Dimmer switches.
35. Bomb jettison switch.
36. Air temperature gage.
37. Direct vision panel knob.
38. Air observer's lamp.
39. Fuse box.
40. Fireman's axe.
41. Camera temperature indicator.
42. Voltmeter.
43. Fire extinguisher switches.
44. Navigator's oxygen tube.
45. Push switches.
46. Fuel contents gage, outer tanks.
47. Switch.
48. Navigation head lamp switch.
49. Downward identification lamp switch.
50. Fuel contents gage, center tanks.
51. Fuel contents gage, inner tanks.
52. Downward identification lamp switch.
53. Oxygen demand regulator.
54. Booster pump switches.
55. Recognition light switch.
56. Watch holder.
57. Power socket.
58. Oxygen contents gage.
59. Oxygen flow indicator.
60. Camera stowage.
61. Navigator's hinged table.
62. Elbow rest.
63. Writing tablet.

a slot in the leading edge of the wing, but the flow is controlled by position of the outlet flap below and behind the radiator cores. A back plate streamlines the air beneath the front spar when the flap is open. Flaps for each engine are separately controlled by switches at the pilot's hand. The electro pneumatic rams are designed to close flaps when the temperature is below 230 deg. F. and open them when it reaches 239 deg. maximum.

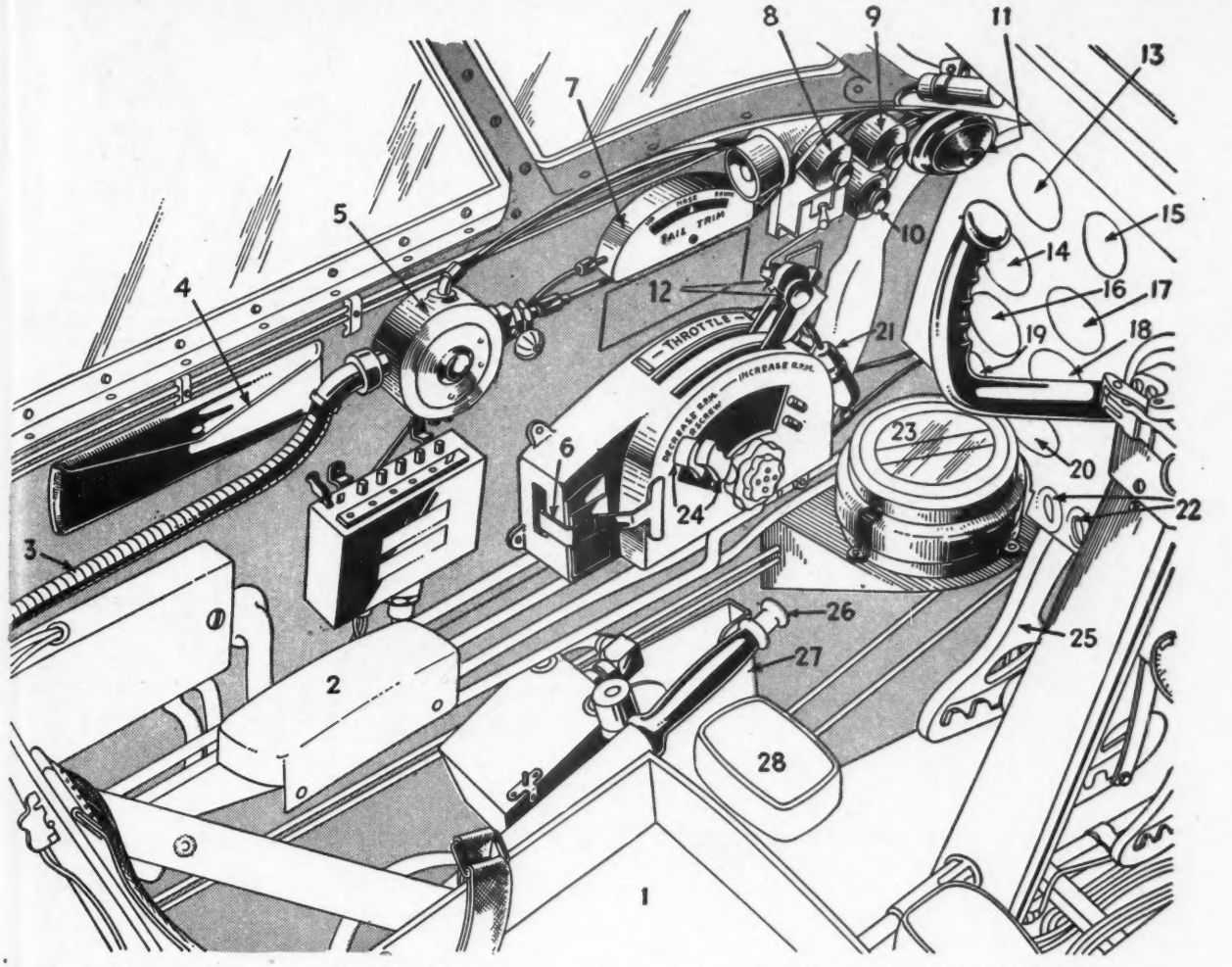
The radiator core is divided into three sections. A small section with a special outlet passage is located next to the fuselage. There is a hand-operated flap in this passage controlled by the pilot. When flap is closed, all air passing through this section of the radiator goes into the cabin through an inlet tube inside of the fuselage. An air tube from cabin to airstream is also provided to exhaust the air.

At the engine side of the radiator there is a honeycomb type cellular core to cool oil in the same airstream but entirely separate from the engine cooling section. The engine cooling radiator core is of the fin and flat tube type.

All oil and liquid couplings are made with the "Alvimo" design. The thermostatic relief valve mounted on the header tank controls pressure in the cooling system and suppresses boiling. It also admits air to the header when temperature falls, thus relieving the system of sub-atmospheric internal pressures. A relief valve opens up at two atmospheres pressure. The vent tube discharges just aft of exhaust stacks.

Fuel System

Fuel is carried in five pairs of aluminum alloy tanks protected by self-



Left hand side of cockpit.

1. Pilot's seat.
2. Pilot's arm rest.
3. Pilot's oxygen tube.
4. Pilot's pouch.
5. Oxygen demand regulator.
6. Supercharger switch
7. Elevator trim tab indicator.
8. Dimmer switch.
9. Dimmer switch.
10. Compass dimmer switch.
11. Ventilator.
12. Throttle controls.
13. Oil and fuel pressure gages.
14. Steering indicator.
15. Radiator temperature gage.
16. Manifold pressure gage, left.
17. Oil temperature gage.
18. Manifold pressure gage, right.
19. Tachometer, left.
20. Tachometer, right.
21. Compass lamp.
22. Landing lamp switches.
23. Compass.
24. Propeller control lines.
25. Rudder pedals.
26. Pilot's seat adjusting lever.
27. Map case.
28. Pilot's thigh rests.

sealing coverings. They are all housed within the main wing and have a total capacity of 674 U. S. gal. Electrically operated gages indicate contents of each pair of tanks. Filler openings are through top of wing or fuselage for all tanks. On the starboard side of the fuselage there is a fuel collection gallery casting that has disk-type nonreturn valves to prevent flow of fuel from one tank to another.

The outboard tanks feed direct to their respective engines, through the main control cocks and through the booster pumps, but they are not connected to the fuel gallery with the other tanks. The fuel gallery feeds both engines from the tanks connected to it. Each pair of tanks is provided with a drain cock and all delivery connections have a check valve so they can be disconnected without loss of fuel. Pressure is applied to tanks, but it can be cut off and the tank vented.

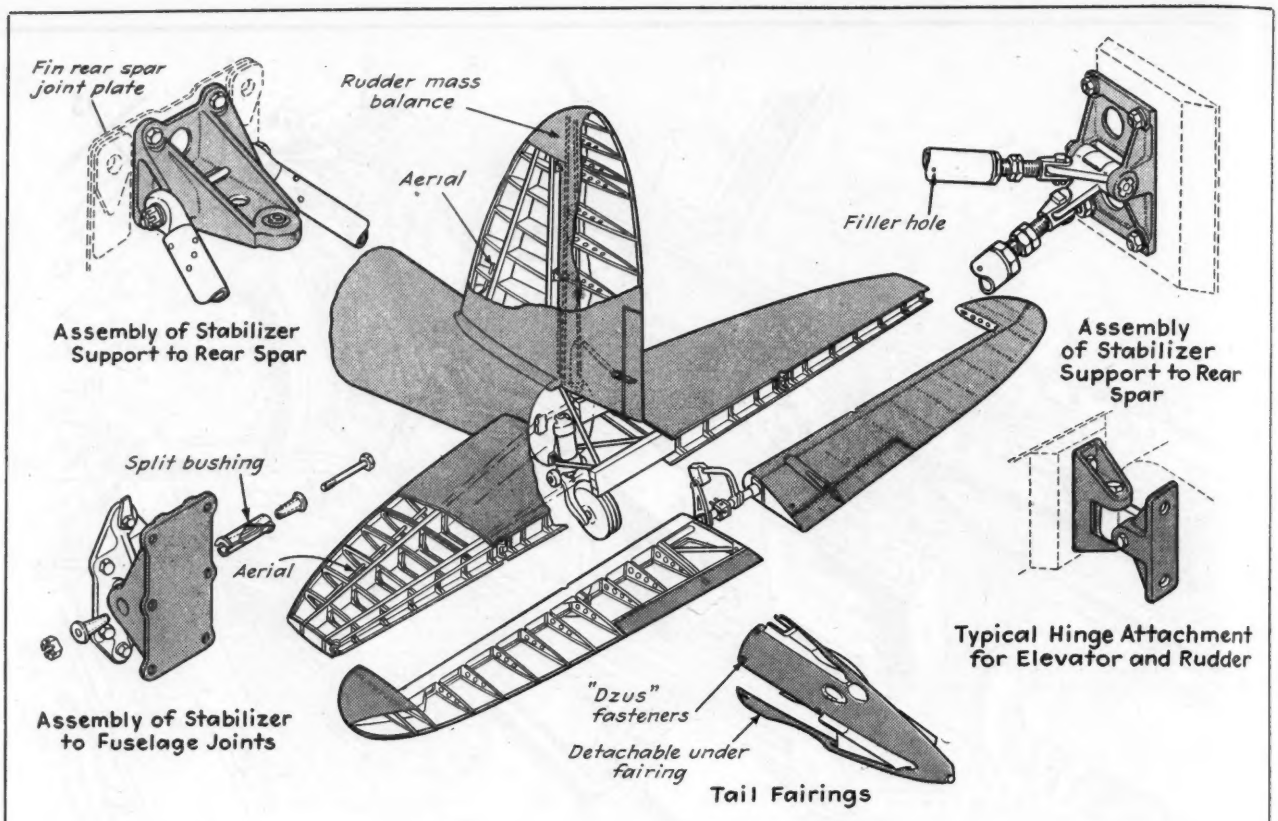
Aileron, elevator, and rudder controls are all operated through cables guided by molded pulleys mounted on sealed ball bearings. In several locations, adjustable tubular connecting rods are used. These are also pivoted on ball bearings.

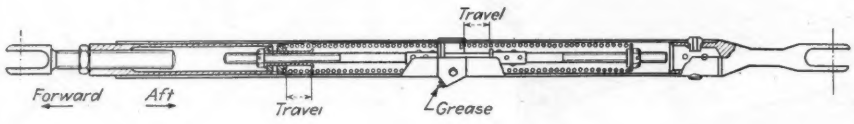
The control column is a vertical tube hinged at the bottom and surmounted by an abbreviated wheel and a thumb lever for operating the brakes. There is no adjustment on the control column for height or position. The pedals, however, are adjustable for leg length and can be set at five different points about 1 in. apart.

Elevator Control

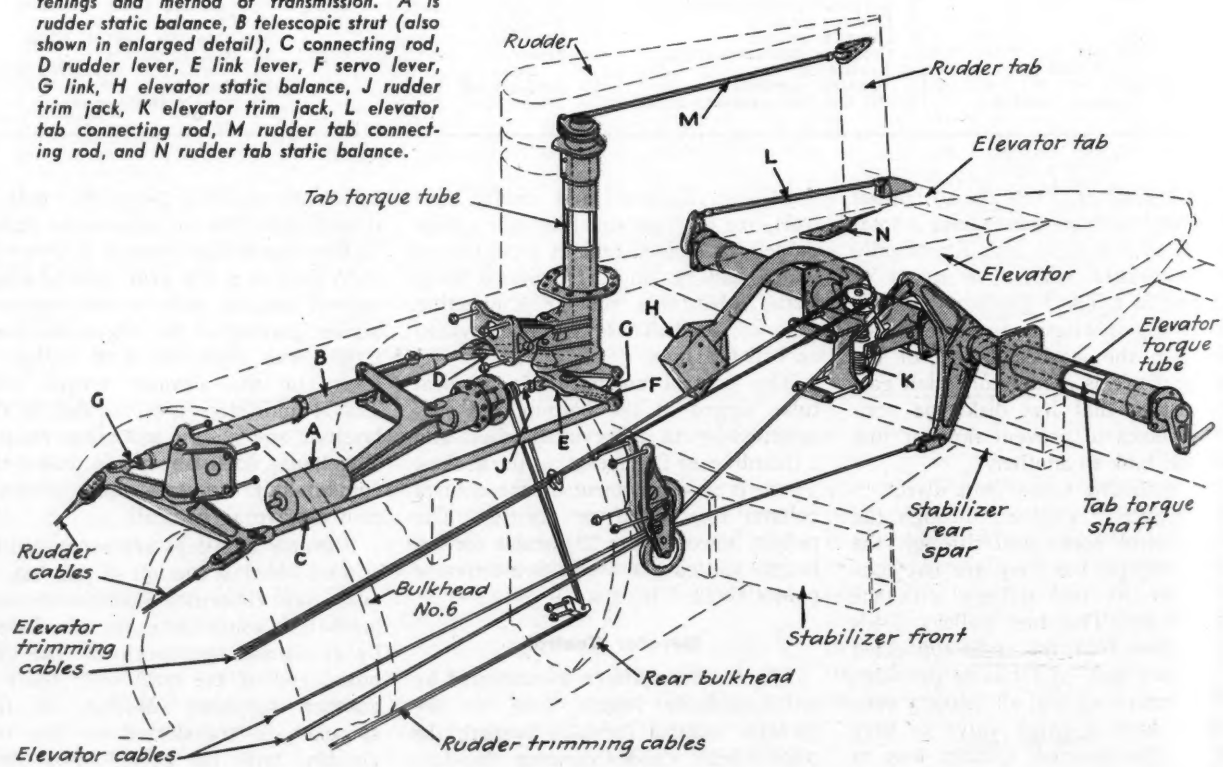
The control column is connected by an adjustable length tube to the elevator control layshaft beneath the pilot's seat. Cables connect the layshaft with a countershaft mounted on the aft-side of No. 4 bulkhead. These cables are attached to circular pulleys at both ends. The second elevator pulley on the countershaft is oval in shape so as to provide a low gear ratio at small control angles with a progressively higher gearing as the angles increase. Cables run from the oval pulley to levers on the elevator torque tube. Travel limit stops are provided on the layshaft and also a trimming weight. This hangs down about 6 in. below the countershaft center when elevator controls are at neutral.

Elevator trim tabs are controlled by a hand-wheel at the left of the seat. A quill shaft, concentric with the elevator layshaft, is connected to the wheel shaft by chain and sprockets. On the outboard end of the quill shaft there is another sprocket. Motion of this sprocket is transferred to the two elevator trim tab cables by a short length of chain and to the elevator trim jack bolted to back of rear





Empennage and controls, with details of fastenings and method of transmission. A is rudder static balance, B telescopic strut (also shown in enlarged detail), C connecting rod, D rudder lever, E link lever, F servo lever, G link, H elevator static balance, J rudder trim jack, K elevator trim jack, L elevator tab connecting rod, M rudder tab connecting rod, and N rudder tab static balance.



tail plane spar. Construction of this jack and its location and method of operation by chain and sprocket are illustrated. From rear bulkhead to jack, the cables, chain, and sprocket are enclosed in a sheet metal tube, the top side of which is removable.

Aileron Control

Motion of the aileron control is transmitted to the bottom end of the control column by chains and sprockets connected by rods. Top sprocket is circular, but the bottom one is oval to give a low gearing around neutral position increasing to maximum at full aileron. The oval pulley is connected to a pulley beneath the seat by a tubular torque shaft. To allow for movement of the control column, a universal joint is provided in the torque tube attachment casting. The pulley on the end of torque tube operates two aileron control cables, which pass down left side of fuselage to rear face of rear main spar and thence over ball bearing molded pulleys to the aileron differential pulley.

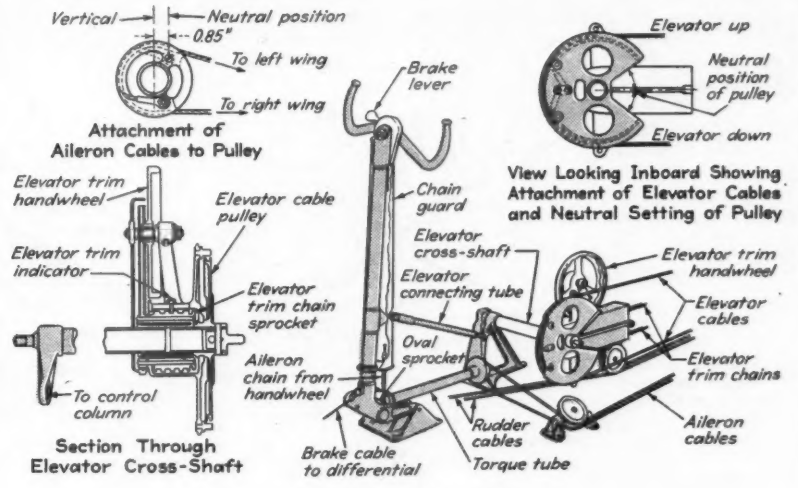
Both ailerons have geared balance tabs. The right aileron tab adjustment is fixed during flight (although adequate adjustment is provided when trimming on the ground) but left trim tab can be positioned during flight. The control with its indicator is on lower right corner of instrument board. This operates with a sprocket and chain, connected to control cables taking same path as aileron control cables to left wing. On the wing a chain and sprocket connection is provided to operate a screw-and-nut type of trim jack.

Rudder Controls

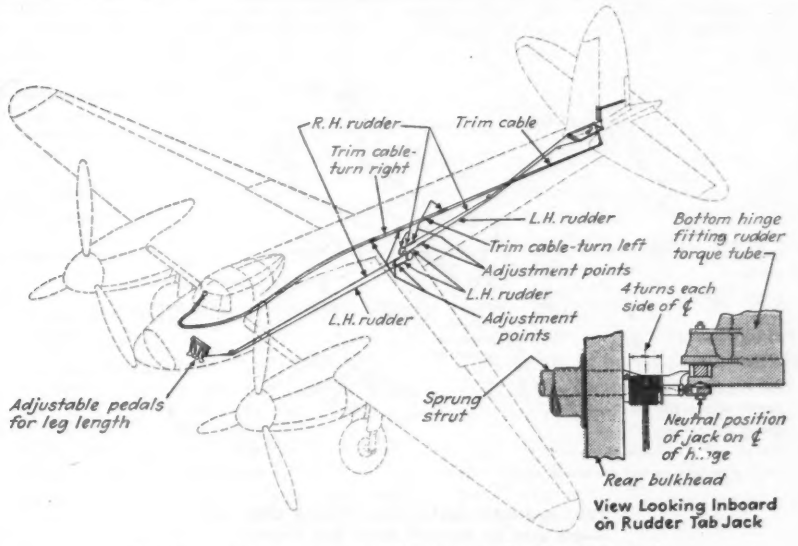
Adjustable rudder pedals are hung from two parallel overhead shafts, the right pedal being suspended from the front one. Two arms on each side of the pedal pad are provided. Each shaft has an arm almost as long as the pedal that is connected to one of the two rudder cables. The latter pass along left side of fuselage to arms of the cable

Control Travel

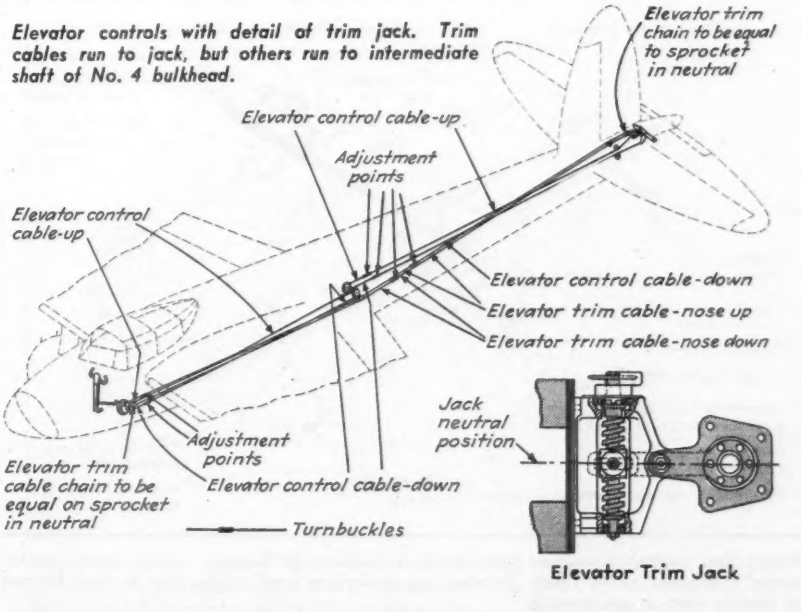
Control column neutral position	5° aft of vertical
At centerline of control col., handwheel travel, forward	12½°
aft	12½°
lateral	none
Elevator travel, above neutral	25° up −1°
below neutral	25° down +2°
Rudder travel	26° (right or left) −1° +2°
Aileron travel, above neutral	26½° up −1°
below neutral	11½° down +2°
Elevator trim tab travel, up or down	7½°
Rudder trim tab travel, left or right	16° + 2½°
Left aileron trim tab travel, up or down	8½° up or 9½° down
Flaps	45° down ± 2° (max.)

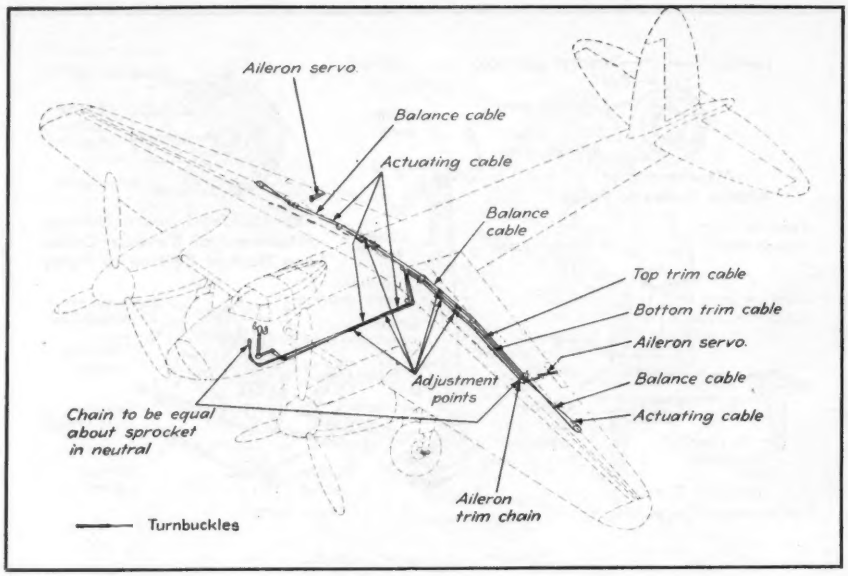


Details of elevator controls.

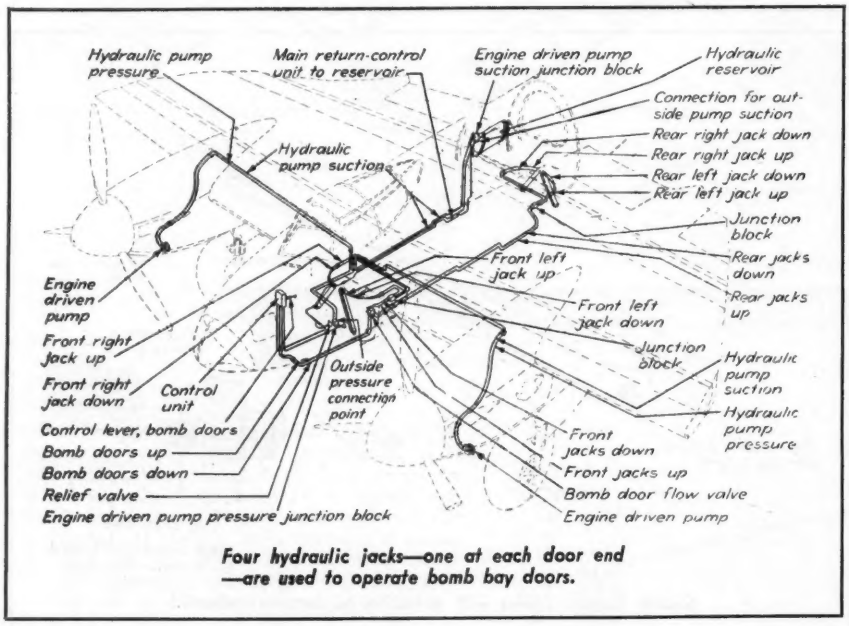


Rudder control cables with adjusting turnbuckles indicated.

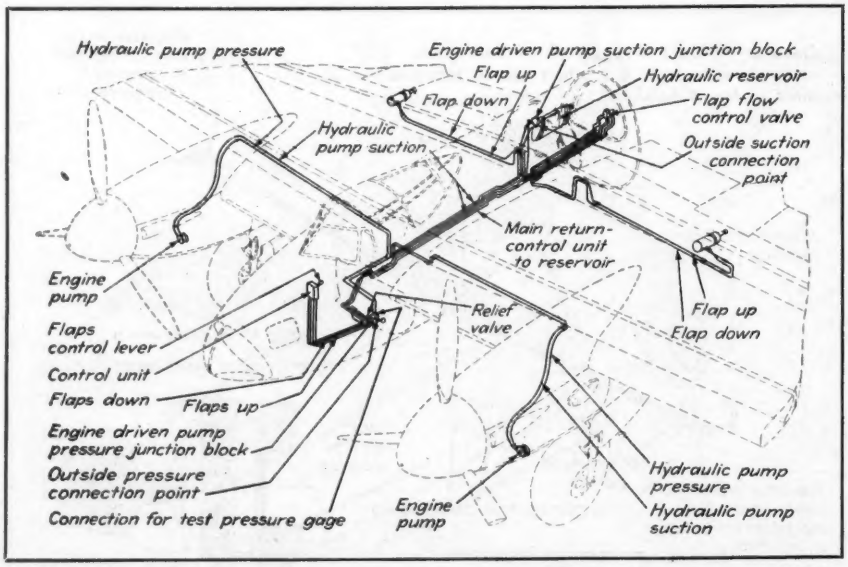

Elevator controls with detail of trim jack. Trim cables run to jack, but others run to intermediate shaft of No. 4 bulkhead.
Elevator trim chain to be equal to sprocket in neutral
Elevator control cable-up
Adjustment points
Elevator control cable-up
Elevator control cable-down
Elevator trim cable-nose up
Elevator trim cable-nose down
Jack neutral position
Adjustment points
Elevator trim cable chain to be equal on sprocket in neutral
Elevator control cable-down
Turnbuckles
Elevator Trim Jack



Aileron controls are operated by cables over ball-bearing pulleys. Right hand tab is adjustable in flight, but left hand one is only adjustable on ground.



Four hydraulic jacks—one at each door end —are used to operate bomb bay doors.



Hydraulic flap controls draw fluid from reservoir in center of fuselage. Lever control valve is in central instrument panel. Both reservoir and emergency hand pumps may be used for operating landing gear in emergencies.

lever, pivoted on the forward side of No. 6 bulkhead. Bulkhead acts as a stop for rudder pedal movement.

Rudder trim tab is operated by a jack mounted on rear face of No. 7 bulkhead, just below rudder. It is operated by small flexible cables wound on a small drum that forms the nut of the trim jack. At the cockpit and the rudder trim control a Teleflex control box is mounted on the center support of the "V" windshield where its crank control is easy to reach and the indicator showing rudder tab position easily read. The Teleflex cable runs from the control through No. 3 bulkhead. From this point to the tab control drum, flexible cables are run over molded ball bearing sheaves.

Rudder tabs not only serve as trimmers but also provide servo action for the rudder. To introduce the servo action a telescopic spring strut is fitted in the rudder control system.

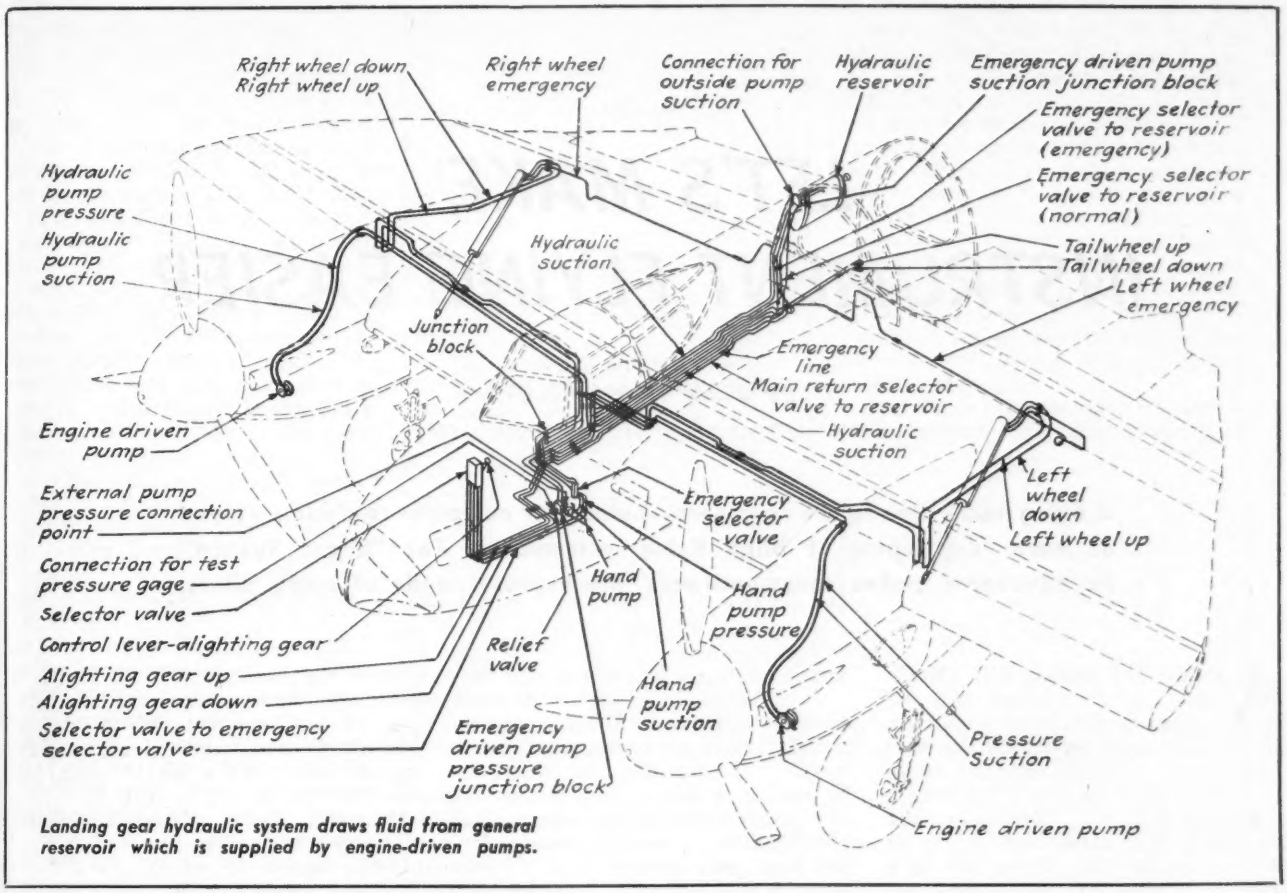
Pneumatic brake control is operated by thumb lever attached to right hand spoke of aileron control wheel. It is provided with finger operated clip so it can be locked in *on* position. A flexible cable transmits brake lever motion to differential control box on floor just ahead of the rudder pedals. Thumb lever merely operates an air valve. The brake control box is also connected to the forward or right brake pedal layshaft. A tubular rod joins the short levers provided at each end. This control divides the braking effort between the landing wheels depending on the position of the rudder pedals. To get even braking, it is only necessary to keep both rudder pedals at center position and control the amount of braking by thumb pressure.

Location of brake differential control valves is indicated in the diagram of the pneumatic system controls.

The pneumatic system controls brakes, radiator flaps, superchargers, and desert air controls, and it has a small single cylinder aircooled compressor on the engine. An air bottle is provided in the after part of the fuselage. Pressure regulator valves, pressure maintaining valve, and oil filters provide adequate volume of clean air. Compressor cylinder is air-jacketed so that a high pressure head of air due to ship speed will be circulated all around it.

Oxygen System

Since the *Mosquito* is used at high altitude as well as for strafing, a com-



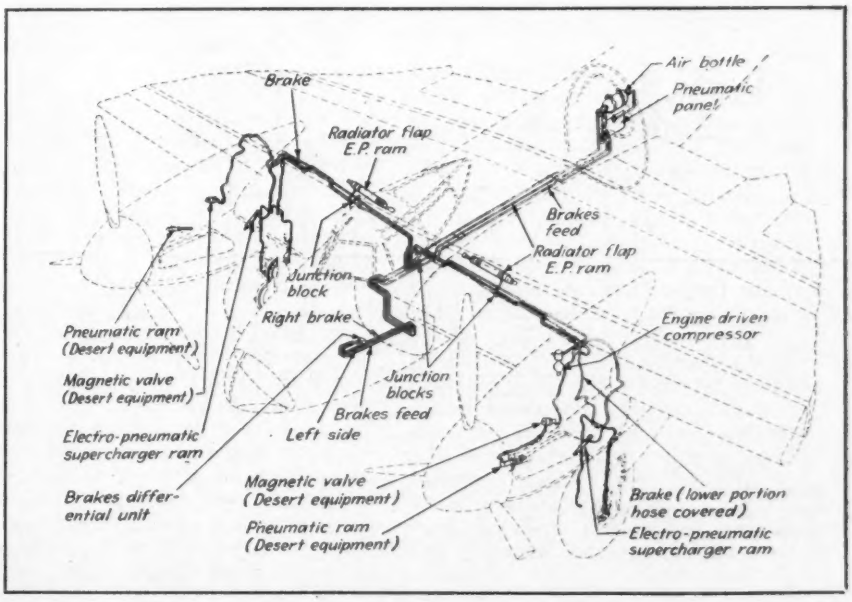
Landing gear hydraulic system draws fluid from general reservoir which is supplied by engine-driven pumps.

plete system of oxygen tanks is provided. Two different demand regulators and flow meters are provided—one for the pilot and another for the bombardier.

For high flying or in cold weather, hot air from the left air heater is directed into the cockpit. Ordinarily, heat is not taken from the right heater where a duplicate installation is provided. However, for photographic work at high altitude it is necessary to keep the cameras warm, so ducts are provided to distribute heat from the right heater where needed. For long distance missions, an auxiliary oil tank is carried in the aft fuselage, and this also is kept warm by the same means. The regular oil tanks for each engine are located behind the firewalls of their respective engines in the landing wheel bays.

The Mosquito is now being built on North America by the DeHavilland Aircraft of Canada, Ltd. Because shipping requirements made it necessary to purchase all equipment on this side of the Atlantic, many new engineering problems introduced themselves, resulting in a tremendous amount of re-engineering before production could be attained. Much credit is due W. D. Hunter, Canadian Chief Engineer, W. J. Jakimiuk, Chief Canadian design development engineer and F. H. Burrell, Chief service liaison engineer, who came from England especially for this project.

Acknowledgment:—This description of the deHavilland *Mosquito* was only made possible by the generous assistance and cooperation of the management and Engineering Departments of the deHavilland Aircraft of Canada, Ltd., and particularly Messrs. J. G. Glassco, controller; L. C. L. Murray, executive director; E. H. Staite, assistant controller; W. D. Hunter, chief engineer; W. J. Jakimiuk, chief design development engineer; F. H. Burrell, chief technical service engineer; D. G. Higgins, public relations; Robert B. McIntyre, chief production-liaison engineer; C. Don. Long, chief project engineer; and W. H. Jackson, development engineer; Joe Holliday, plant photographer; R. V. Corlett, methods engineer; W. K. Aykroyd, chief draughtsman; C. E. Cowtan, air publications section; H. R. Johns, service inspection; and John Greeniaus, Lorne Janis, and F. Willcox.



Pneumatic controls operate brakes, air intake flaps, supercharger controls, and radiator flaps for regulating engine temperature. Compressed air is supplied by left-hand engine-driven compressor and is stored in bottles for emergency use.

LET'S MAKE INSTRUMENT FLYING EASIER

By JEAN H. HAMELET,
Flight Captain, Consolidated Vultee Aircraft Corp.

A flying man's plea to the engineers—calling for complete re-design instead of mere re-grouping of blind flying instruments. The "Cross System" he advocates makes sense, answers the express needs of many pilots.

AIRSPEED 130, heading 110, altitude 5,000. . . . Listen, that on-course signal is building up pretty fast, I better start turning to the right . . . left . . . no, right, of course . . . Wait a minute, what's the heading of that leg—142? . . . Yes, that's right. But watch that airspeed—is it 135 or 125? . . . Oh, 135. Better pull up a little. . . . And that gyro horizon was not set so well, after all. On course coming fast . . . let's turn a little more . . . Altitude, Oh! oh! that needle moved to the left . . . Heading, airspeed, altitude, ball in the center, what time is it—33? . . . No. 32. Should be over the cone in 7 min. . . . 32 plus 7 is 39. Yes, 39. Let's call the tower . . . 135, 130, 39, 5,000 . . . airspeed, altitude, climb indicator, gyro, horizon . . . gyro, heading, altitude . . . Let's keep our eyes moving, as they say in *THE BOOK*. Watch the instruments . . . Hell! I sure keep them moving, and my neck, too. I can't see that altimeter behind the wheel—or if I see it, I can't see the gyro! Listen, it's a faint *N* now, 135, no, 145 will do . . . 130, 39 . . . Barnesville Radio, Barnesville Radio. (Watch that heading, you fool). . . . This is number so and so. . . . "

That, gentle reader, is a quick glimpse inside the brain of a pilot flying on instruments—not one of those veterans with so many hours on instruments that the beam seems to follow them but just an ordinary nonsuperman flyer.

There are, of course, many one-man orchestras boasting outstanding careers. One well-remembered gent, for example, played drums with his right foot, a sort of xylophone with his left, a violin with his hands, and a flute with his nose. The tune was *Tipperary*. But this is the Century of Progress, hence *Tipperary* is now nearly forgotten. Today it's *Mairzy Doats* and we seem to ask our pilots—some of them young pilots with few instrument hours—to cheerfully sing *Mairzy* while hitting a cone.

One of the main reasons they find it well nigh impossible to even graze the cone (let alone tackle *Mairzy*) is the lack of standards in panel placement of the everincreasing number of instruments. One plane will have them arranged one way, another craft will have them in a completely different pattern. *The Book* says the basic instruments—airspeed, turn-and bank, altimeter, climb indicator, and clock—must be mounted close together.

They are. But who would use the basic instruments for a smooth range flying a big modern plane? It is impossible to do a good job without the gyro instruments—the artificial horizon and directional gyro—and there are such others as the direction finder, radio compass, landing indicator, or radio altimeter. Yes, and there'll be more in the future.

Unless some logical disposition is adopted for all these instruments, pilots will have increasing difficulty getting ac-

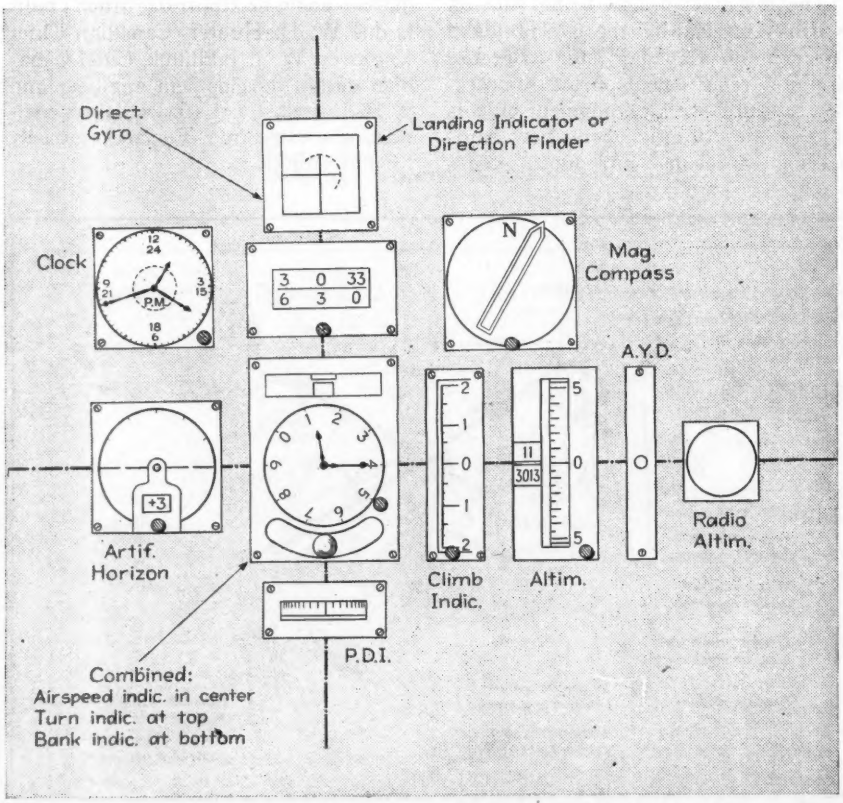


Fig. 1. Here is how "Cross System" instrument flying panel would appear. Note that altimeter and climb indicators are on vertical lines, while those for maintaining heading are on horizontal line. Airspeed and bank-and-turn indicators have been combined in one dial.

customed to the new types of airplanes.

But what is just as important is the makeup of the instruments themselves. Almost without exception, they have round dials, with one, two, or even three needles each. The cockpit of a modern plane has become a nightmare of crazy clocks which read 6,500 ft., 230 deg., 170 mi. (or maybe knots), 32 in., 2,200 rpm., right turn, and 30-deg. bank. There is even one that gives the time, surprising as it may seem, although it does so in a crazy way, as will be shown. All these needles move to the right, to the left, up, or down—with no more apparent reason than individual fancy.

Some efforts have been made, it must be conceded, to simplify things. Apart from the fact that the four or five basic instruments are grouped together, most plane makers also place the gyro instruments side by side, also dispose the engine instruments so that the vertical position of the needles corresponds to cruising speed. This is an excellent idea, since a glance will, accordingly, tell if something is wrong.

This is, in fact, the very principle which the writer would apply to *all* the blind flying instruments.

As will be seen in Fig. 1, some of the instrument dials would have unusual shapes. Even the central instrument looks strange—being an airspeed and bank-and-turn indicator combined in one.

But note this: All the instruments actually used to keep the *heading* are on a *vertical line*. All the instruments used in keeping the *altitude* (including the *attitude* of the plane in a climb or glide) are on a *horizontal line*. This is what we will call the *Cross System*.

Note also that, wherever possible, round dials have been eliminated—for, as more than one pilot has said, "all those things going in circles make you dizzy." Well, doesn't altitude suggest the idea of a vertical scale? Okay, our altimeter *looks* like a vertical scale. So does the climb indicator. The directional gyro, though, is on a *horizontal* scale. As for the central instrument, the pilot can rotate the whole airspeed indicator, dial and needle —to set it so that the needle points horizontally to the right (in the illustration it shows 140 mph.). This means that in working an orientation problem with an airspeed of, say, 140 mph. at 11,000 ft., it isn't necessary to watch all the individual instruments on the horizontal line.

If the nose of the airplane moves up, all the needles on these instruments will move upward—not simultaneously, of course (for they have different lags) but all in the same direction. If the nose of the plane drops, all these same needles will move down. Their movement will be so obvious that the pilot may concentrate entirely on the vertical line, especially on the directional gyro and the turn indicator, which have been put as close as possible, one above the other.

The magnetic compass, which is not used to actually hold a heading, is placed, along with the clock, to one side, for both are instruments consulted only from time to time.

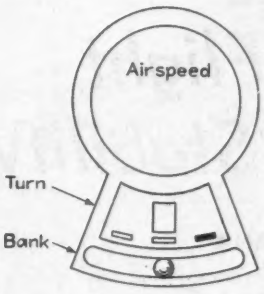


Fig. 2. Feasibility of combining airspeed with bank-and-turn indicator is shown by this type, manufactured in Europe for many years.

Despite their unusual shapes, there is no special difficulty in making these instruments. A combined airspeed and turn indicator, for example, has been manufactured in Europe for years, although in a somewhat different way (see Fig. 2).

The only graduation which would show on the proposed altimeter dial would be between plus-500 and minus-500 ft. The thousands-of-feet would appear in a small window just above the altimeter setting. From the side, this instrument would appear like a drum, as shown in Fig. 3. The rate-of-climb indicator dial would appear much the same, graduated from plus-2,000 to minus-2,000 ft., which appears adequate.

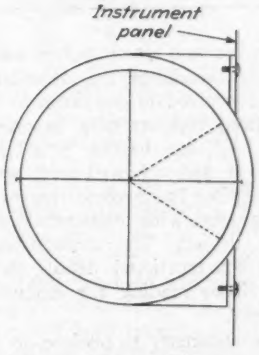
The artificial horizon has a figure (plus-3 in the illustration) showing in a little window. Different figures correspond to different positions of the little airplane image above or below the horizon, for the figure-showing device is connected with the knob used to reset the silhouette. The idea is this: Usually the resetting of the plane image after a change of power or airspeed, or both, is done after the new position of the ship has been held for a certain time. This is a waste of time. With our device, it will be easy to memorize which figure corresponds to such power and such airspeed. Before we adopt a new power setting, we will bring the new figure in the window with the resetting knob, changing at the same time the position of the plane image. Then as soon as the new power setting is obtained, we'd simply bring the horizon back on the image with the stabilizer.

This device should come in pretty handy during the flap lowering operation, as leading the airspeed indicator is rather difficult with flaps lowered. Instead of waiting for the new airspeed to be obtained after lowering the flaps, and only then resetting the artificial horizon, we will do the resetting first, then lower the flaps, adjust the power, and bring the silhouette back on the horizon with the stabilizer, thus stabilizing the airplane immediately.

It may be noted in Fig. 1 that our clock has a 12-hr. dial of the good old grandfather type, with only a little difference: The numbers 13, 14, 15, etc., are also shown on the dial, below 1, 2, 3, etc., also a P.M. mark appears—automatically of course—on the dial when you must use the bigger numbers.

We have been brought up with clocks which showed 12 at noon, but now the fashion seems to be clocks which show noon at six!* To avoid a 12-hr. error, which nobody should make, we risk a 1-hour error, which is much more dangerous because it is much harder to detect. A 12-hr. dial clock is an instrument to which we are so much accustomed that we often won't have to look at it closely to know the time.

And this is exactly what we want—to make things as easy as possible for the



Section of the Altimeter, Seen from Port (Left side of ship)

Fig. 3. Side view of proposed altimeter set in instrument panel. Only graduations between plus-500 and minus-500 ft. would show on dial; thousands-of-feet would appear in small window just above altimeter setting.

poor fellow behind the wheel. Some people will think that we are too old, but I would like to see them "on instruments," trying to figure if "7" is really between "6" and "8", as shown on the new super-duper 24-hr. dial clock.

Naturally, we want all the instruments on the horizontal bar of the cross to show above the wheel for convenience of a pilot of average size. Seat adjustments could be provided for basketball players and for undersized fellows.

Needless to say, *Mairzy Doats* will have long been forgotten before our remarkable inventions are adopted. Our lucky instrument flyers of the future will have to whistle another tune. But meanwhile —from one who learned the hard way —here is a prayer: "Please, dear engineers, no more of this hide and seek with the directional gyro or altimeter—or both."

* The new Navy clocks have their dial divided into 24 units instead of 12, thus actually showing 6 when it is 12 o'clock.

Automatic Flight And Airplane Stability

By STEPHEN J. ZAND

Director, Vose Memorial Laboratory, Sperry Gyroscope Company, Inc.

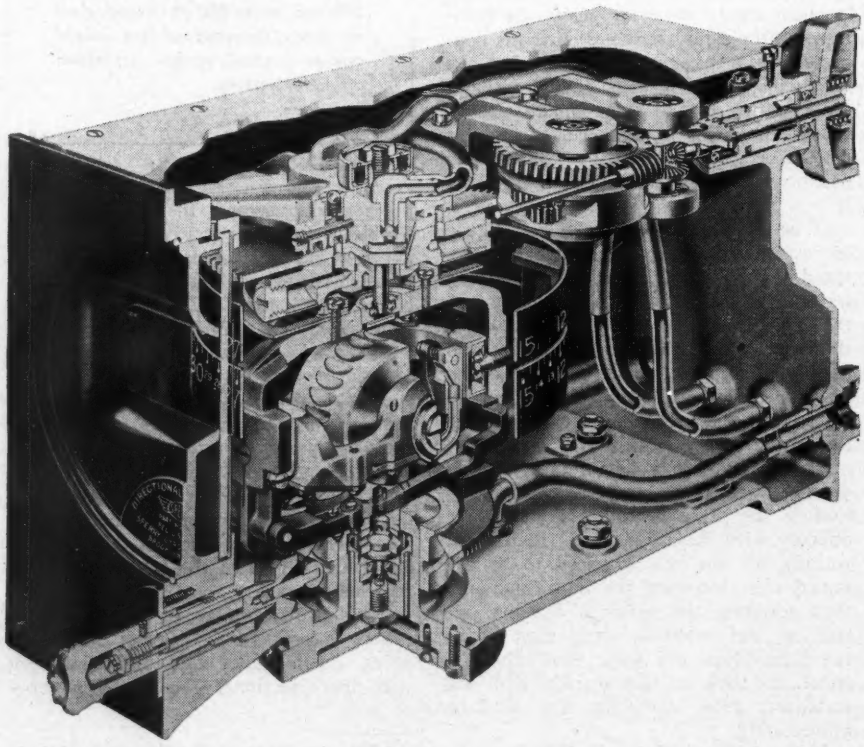
A complete understanding of the fundamentals of the automatic pilot requires a specialized review of airplane stability. Mr. Zand's approach to a clear description of automatic flight principles is a notable technical reference work.

AMONG THE MANY INSTRUMENTS used on airplanes the automatic pilot, conceived in one form in 1913 and introduced commercially in many forms about 1933, has become standard equipment now and achieved such prominence that the time has become ripe to acquaint the engineers with fundamental principles of this device. The usual discussion of purely constructional details can be obtained from reading the extensive trade literature.

It is customary to preface an article of this nature with a chronological and historical outline of the development of the device. In this case we shall omit this introduction because to do justice to the broad subject, to give credit to all designers, inventors, experimenters, and manufacturers, one would have to write almost a book. The subject is fascinating in itself and fortunately for us, has been thoroughly covered by a series of papers written by the Belgian scientist, F. House, in 1935 and 1936. His work was translated and published as a technical note by the NACA, and is, therefore, available for the student of aeronautical history.

Automatic Pilot Defined

The automatic pilot should be a substitute for the airman, (we use the term "airman" rather than human pilot to avoid confusion; by using two entirely different words, all ambiguity in reference to the flying functions will be avoided).



Sperry directional gyro which actuates the rudder and serves to maintain the airplane on a fixed course while plane is under automatic pilot control.

In other words, one sets as desideratum that the automatic pilot keep the airplane on a trajectory chosen by the navigator in such a way that safety, economy, speed, altitude, comfort, etc., give the best all around compromise. Once this trajectory is established and reached, the automatic pilot should keep the airplane rigidly on it which implies that the c.g. of the airplane will follow a predetermined line or curve in space; further that the motions about the c.g. of the airplane are eliminated. Under such conditions the airplane follows a chosen geographic direction, its speed remains constant and its altitude above a chosen reference line such as sea level remains unaltered. Such ideal flight is of course possible for a short time interval. Practically, the motions about the c.g., and the displacements of the c.g. will not be completely eliminated. They will occur, but a good automatic pilot will always bring the airplane back to the chosen trajectory, and the integrated path will be substantially as originally planned. The better the design of the automatic pilot, the smaller should be the momentary departures.

Attacking the Problem

If we were assigned the task of designing an automatic temperature control for an icebox, only the most inexperienced engineer would proceed immediately and embark on the exploration of the available thermostats, switches, wiring, etc. Any logical person would attack the problem from a basic point of view. He would find out such things as how much refrigeration is required, how much heat is radiated in the icebox without automatic control, what is the rate of heating up of the food cabinet, what is the heat absorption of the food customarily stored and so forth. Only after all those elements have become thoroughly investigated and translated into engineering language by means of formulas and charts, would one proceed to design suitable control elements. The chances of the successful accomplishment of our assignment in following this method is much greater than if one embarks blindly on the design problem without studying the underlying fundamentals. Many other analogies could be described. All of them would lead us to conclude that in order to be able to design a successful automatic pilot, and apparatus controlling the motions of the airplane, we have to get intimately acquainted with the free, unrestricted motions of the airplane. Consequently, a thorough knowledge of the stability of the airplane is a pre-requisite toward the successful solution of the problem of automatic flight.

Static and Dynamic Stability

Since the beginning of aeronautics, it has become customary to divide stability into two separate studies: static stability and dynamic stability. The reason for this division lies probably in the fact that designing the airplane so as to have it statically stable, i.e., in such a way that when displaced from a given attitude, it sets up forces and moments tending to restore it to the original attitude, is fairly easy. The computations involved are

algebra and arithmetic. Relatively simple criteria establishable in the wind tunnel suffice since static stability is directly proportional to the slope of the moment curve.

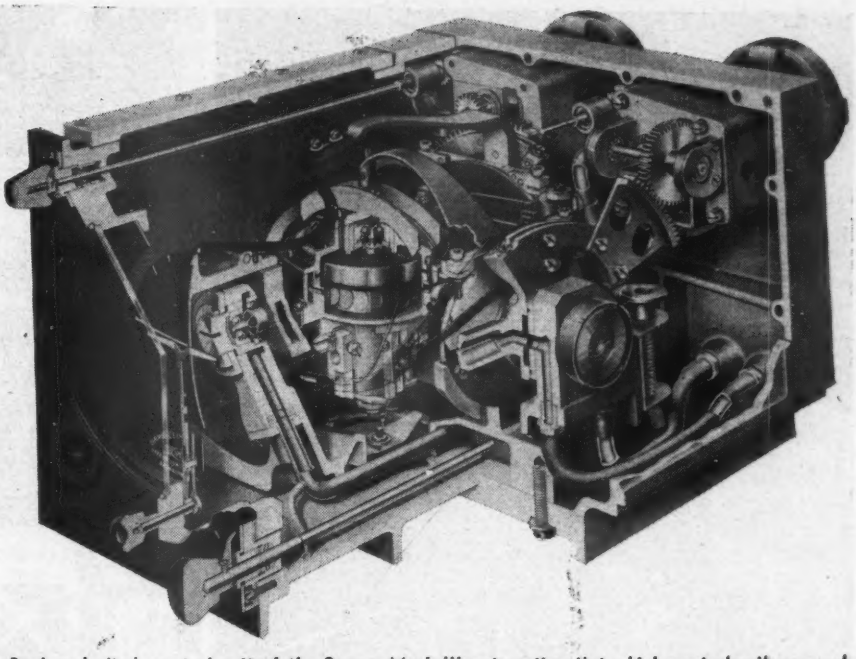
Dynamic stability on the other hand is much more complicated since it involves the study of the motions due to static stability. In pursuing this work we have to ascertain whether the ensuing motions are stable and whether the oscillations resulting from the airplane's return to its original trajectory are quickly damped out.

Bryan in 1911 was the first to write a treatise on dynamic stability. By assuming the airplane to be a rigid body, he showed that the complicated motions could be separated into as few as two major components; a symmetrical motion along the pitch axis and an asymmetrical one along the roll and yaw axis. Bryan's work was extremely interesting and very thorough, especially if one considers the time when it was written. But it is understandable only to a highly trained physicist and first-class mathematician. To the aeronautical engineer it gives very little insight into the workings of dynamic stability as the practical side and design criteria are not treated at all. It was Jerome Hunsaker who, in 1915 and 1916 in his famous Smithsonian paper, presented for the first time a method of attacking the problem from which definite practical conclusions could be drawn. Later on many other scientists added to this knowledge. Notably, Melville Jones, Dr. Bairstrow, Glauert, Price, and many others published numerous works bringing the problem progressively nearer a practical engineering solution. The study of dynamic stability has progressed by now to a point where one can predict from the theoretical conclusions, practical results. The agreement after test flights are made is surprisingly close.

Basic Equations

This fact is gratifying and encouraging, but let no one think that either the theoretical or the practical work is simple. Both are extremely laborious at best. The purely mechanical part of the calculations is time-consuming and unless properly organized, may lead to utter confusion.

For all practical purposes the airplane may be regarded as a rigid body. Six equations are, therefore, required to define its motions: three force equations and three moment equations. These equations must include forces and moments due to aerodynamic reactions and those due to mass reactions. Obviously to make the setting up of the basic Newtonian equations easier, we must choose a convenient system of cordinates. We choose, of course, a Cartesian system, and the proper origin of the system is best taken as the c.g. of the airplane. Then we proceed, as in all problems of dynamics, to equate mass acceleration along each axis to the appropriate component of the applied force. Further, by equating rate of change of moment of momentum about each axis to the appropriate applied moment, we obtain the six basic equations which must be satisfied throughout the motion of the airplane. Using NACA conventions and notations we can write:



Bank and climb control unit of the Sperry Mark III automatic pilot which controls aileron and elevator movement when airplane is under control of the automatic pilot.

$$m\left[\frac{dU}{dt} - VR + WQ\right] = X - mg\sin\theta$$

$$m\left[\frac{dV}{dt} - WP + UR\right] = Y + mg\cos\theta\sin\phi$$

$$m\left[\frac{dW}{dt} - UQ + VP\right] = Z + mg\cos\theta\cos\phi$$

$$\frac{dh_1}{dt} - h_2R + h_3Q = L$$

$$\frac{dh_2}{dt} - h_3P + h_1R = M$$

$$\frac{dh_3}{dt} - h_1Q + h_2P = N$$

where the velocities about the X, Y, Z axes are denoted by U, V, W forces by X, Y, Z. The angular velocities are P, Q, R; moments L, M, H. The moments of inertia are A, B, C; the product of inertia D, E, F, and finally the moment of momentum we will call h_1, h_2, h_3. The expressions for the moment of momentum can be derived from the following three relations:

$$h_1 = AP - FQ - ER$$

$$h_2 = BQ - DR - FP$$

$$h_3 = CR - EP - DQ$$

Solution of Equations

The general solution of the basic equations could perhaps be accomplished by means of the so-called "step by step" method. The maze of mathematical expressions soon loses practical signifiance, however, and in order to make our work practical it is necessary to adopt certain simplifications. Naturally, those simplifications have to be reasonable and based on logic. Sir Melville Jones treats the subject, both the solutions of the equations and the simplifications adopted, very masterfully. His work can be found in Volume 5 of the *Aerodynamic Theory* edited by Durand. Diehl in his book "Engineering "Aerodynamics" gives an excellent review of Jones' work and shows how the stability biquadratic is derived. The simplifications generally accepted are first to assume that the departures from the initial state are small both in respect to angles and to velocities. Then the second order products become so small that they can be neglected. Taking this into consideration, we can say that the X, Y, Z, forces will be a function of U, V, W, P, Q, R. We don't know, however, what the function is. Fortunately, for small oscillations we can perfectly legitimately expand this function by the MacLaurin theorem and obtain expressions (by neglecting the second order terms, of course) for the aerodynamic force derivatives. They will be partial derivatives which can be substituted for the mass forces in the previously described six equations of motion. The results of the substitution can be grouped into two sets of three linear differential equations with constant coefficient: the first in U, W, θ the second in V, ψ ϕ. Since experience shows us that motions are of an oscillatory nature, we deduce that each variable must be some function of $e^{\lambda t}$. Then each group of three equations can be combined into a biquadratic of a general form: $A\lambda^4+B\lambda^3+C\lambda^2+D\lambda+E$ where A, B, C, etc. are functions of the stability derivatives and λ is the damping coefficient. The solution of the biquadratic presents serious mathematical difficulty since as we all know, no general solution of any equation above third degree, exists. Fortunately, approximate solutions have been found and since, very broadly speaking, all airplanes are somewhat alike the order of magnitude of the stability derivative and, therefore, of the coefficients A, B, C, etc., will be comparable. Consequently, once a pattern for a solution is found, a subsequent refinement and adaption to a variety of

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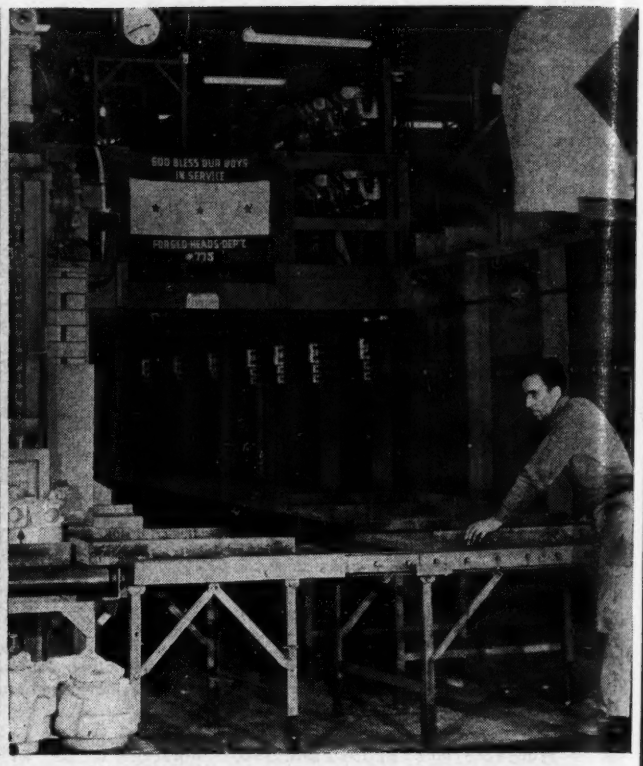
Mounted on column of Bullard Mult-au-matic this target fixture assists in rapid locating of cylinder head forgings.



Loading end of continuous conveyor gas-electric heat-treating furnace used for treating cylinder head forgings.

Forged Cylinder Heads Require New Technique

Cutting a cylinder head out of a solid block was always considered "quite a trick, if you can do it". This is the story of how it was done.

PUBLICLY ANNOUNCED 18 month ago, the forged cylinder head for Wright *Cyclone* engines was not immediately placed in production due to time required for obtaining special machining equipment, now installed and in full operation.

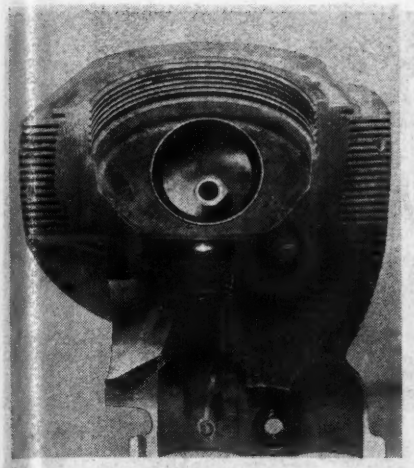
Production of forgings was left to companies specializing in this work, equipped with the extremely heavy presses and upsetters essential to these operations. Heads are delivered in "as forged" condition, and weigh approximately 65 lb. First step is heat treatment, and is extremely critical. Machining speeds and feeds are so high that even slight differences in heat treat and consequent material structure will appreciably affect tool life and quality of finish.

Continuous-conveyor gas-electric furnaces are employed, in pairs with a gravity roller conveyor between them for return of the carrier trays. Nine forgings are loaded on to a tray made of subway grating, and two of these are placed on the loading extension of the furnace. A hand crank moves the trays into the furnace vestibule. Power-driven rollers carry the trays through the first heating section where they remain for 6 hr. At the end of this period the trays reach the discharge door which opens automatically, while at the same time a high speed driving mechanism ejects them on to the cooling conveyor with the minimum loss of furnace heat. Forced draft cooling is employed, air being driven upward into the hollow base of the forgings, which are then loaded automatically into the second stage furnace from which they are again ejected, cooled, and loaded into the third stage. After the final cooling the parts are removed from the trays which are then returned gravity conveyor.

In the first machining operation the parts are mounted in chucks, resting on equalizing buttons, and are held by the chucking piece. Before first cut is taken work is trued up by targets and flush pin gauges on the machine column, supported that they may be raised out of the way to allow the machine to index. Outside is finish turned, flange finish formed, and first fin groove finish turned, then transferred to a second Mult-au-matic in an inverted position, the chucking piece faced off, and the interior dome rough and finish formed.

Locating holes are now drilled and reamed on an Allen drill. This is a three position indexing machine having two two-spindle heads and three trunion-mounted fixtures to facilitate loading. Parts are loaded in an upright position, locating on the flange diameter, and targeted on the rocker boxes. After clamping the fixture is inverted to present the base of the flange to the drills.

Heads are next conveyed to a Cincinnati Hydro-matic Rise and Fall machine on which the upper curve is profile milled, after which they are mounted on carrier plates before passing to the Greenlee transfer machine. Parts are loaded into the first, or 16 station section, so that the rear of the head faces the right side of the machine, and at the first operation both rocker box faces are rough milled, removing about $\frac{5}{16}$ in. of stock with end cutting mills. At the next operation a $\frac{1}{2}$ in. hole is drilled and reamed,



Cross section through Cyclone forged cylinder head showing complicated forms machined in ports and rocker box.

and then the two spark plug holes are drilled, counterbored, and chamfered. A hydraulically operated arm now picks up the head clear of the conveyor, tilts it to remove chips and oil, and replaces it.

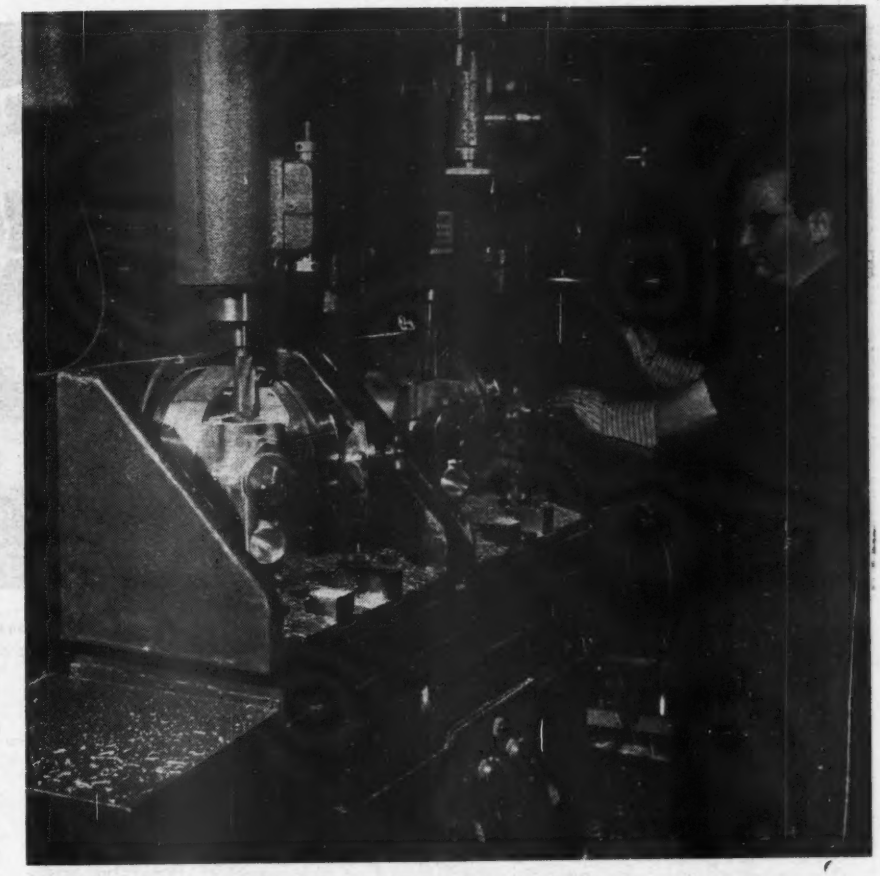
At this point a manually operated turntable is incorporated in the track to enable the second operator to turn the head a quarter turn so that the rocker boxes face lengthways of the machine. This operator then advances the head into the second, or 35 station section where the first operation consists of drilling two $\frac{13}{32}$ dia. holes near the ends of each rocker box and rough counterboring the valve spring counterbores to $1\frac{25}{32}$ dia. the valve holes are next drilled $\frac{3}{4}$ in. dia. through into the dome and finish counterbored to $2\frac{1}{2}$ in. dia.

Opposite or push rod ends of the rocker boxes are then rough and finish counterbored to a spherical radius. A clearance recess is end milled at valve ends and then push rod holes are drilled through and counterbored. At next station rocker shaft holes are drilled, after which a $1\frac{1}{8}$ in.-wide slot is milled between valve and push rod counterbores. Finally two holes are drilled and reamed for the fin bracing and thermocouple tubes, the latter being also counterbored.

Head is again raised and inverted to remove oil and chips and advanced to the third or twelve station section. Before this, the part has passed through the section for rough and semi-finish counterboring the valve seats. Emerging from here it is tilted to remove chips, righted, and passed through an automatic wash machine.

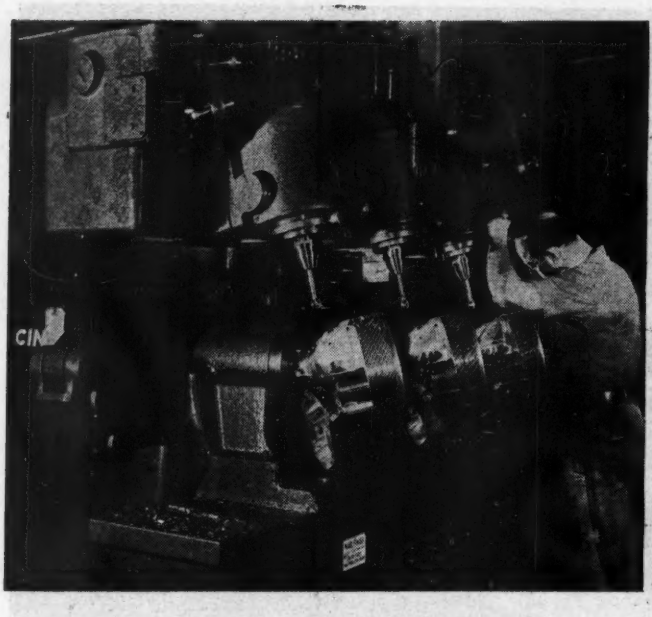
Next machine comprises a total of 63 stations, of which 23 are active, or operating, three are loading, three unloading, and the remainder serve to allow access to the tools. It has a length of 110 ft., and is equipped with a total of 41 tools to perform 40 operations. These include 4 milling cutters, 15 drills, 3 reamers, 17 counterbores, and 2 end mills.

After the wash machine, heads travel by conveyor to Snyder mills equipped with three inclined spindles each driven by its own high speed motor. Parts are

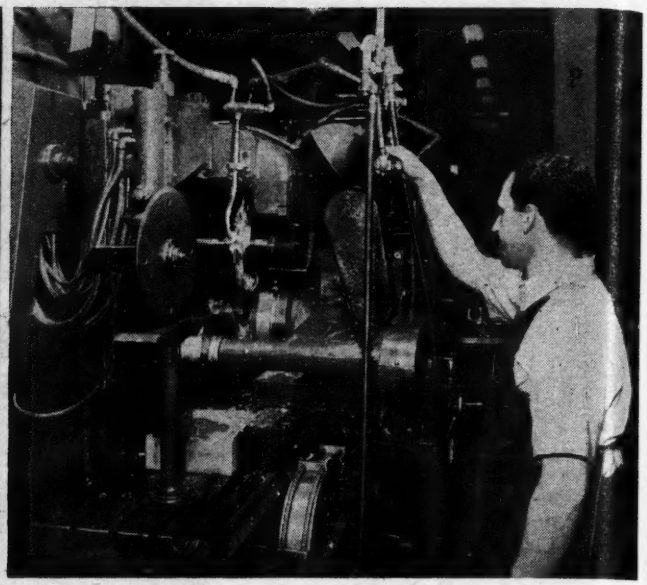


Port faces are rough and finish milled on two-spindle Cincinnati profile millers.

Special inclined-table Snyder machines form complicated intake and exhaust valve chambers.



Specially designed Cincinnati Hydro-tel high-cycle motor-driven profiling machines generate form of intake and exhaust ports.



Rotary cam and follower guide twin saws which shape body fins on Cincinnati Hydromatic mill.

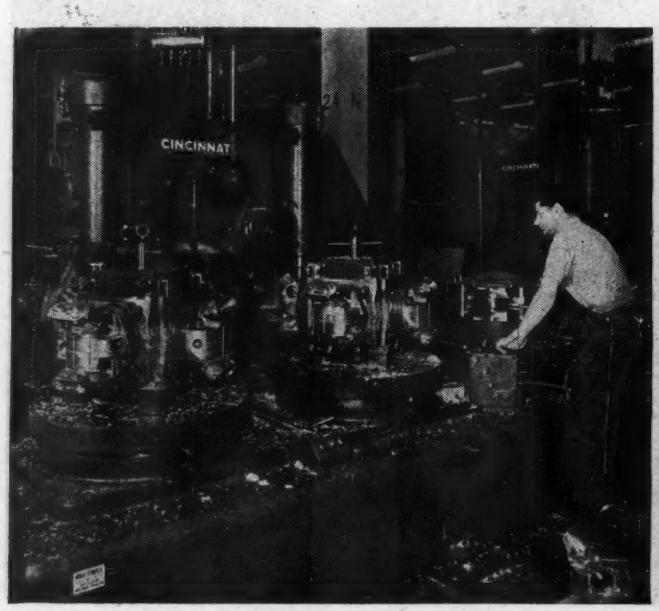
located by the carrier plate on which they passed through the Greenlee, and are clamped to a power operated table. The spindles feed to the depth of 0.175 in., and the table then advances to produce the 5 in. slot. After finning, these slots receive fin-bracing reinforcing strips.

Carrier plates are now removed and the parts passed to Allen drills provided with a four-position indexing table and three drill heads, each having eight spindles. The cylinder heads are loaded in an inverted position, locating by the dowel holes and the center bore. At the first index the drills start the holes to a depth of approximately ½ in. at the second the holes are drilled through, and at the third are reamed and countersunk. At a later operation anchor tubes are inserted into these holes to serve as fin braces.

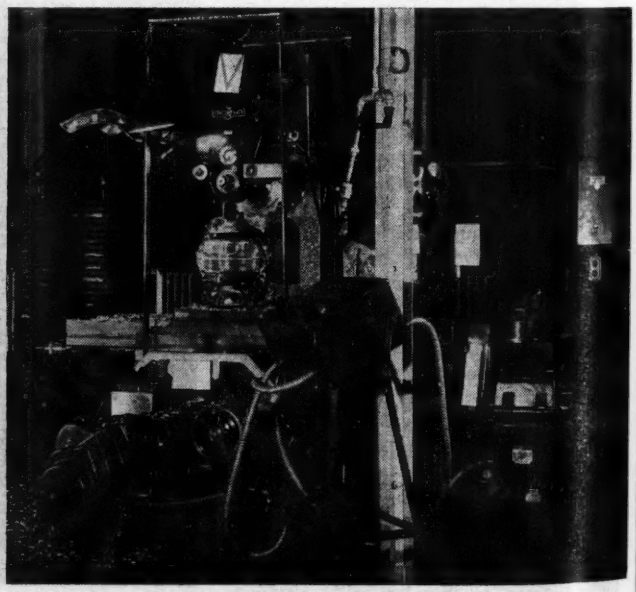
The next operation consists of machining out the exhaust valve chambers so as to leave a central truncated cone in the form of a portion of a helix. This somewhat difficult form is generated on a Snyder machine built to Wright designs. The part is held on a rotary fixture inclined at the angle of the valve guide cone, located on the valve spring counterbore and rocker box slot. The form end mill used is .030 smaller in diameter than the required width of the cut, and is fed in to finish depth for the roughing operation as the part makes one complete revolution on the table. The tool is then set over .015 in. toward the inner side of the cut for the finishing operation and then .015 in. toward the opposite side for finishing the other side of the cut. For finishing, rotation of the head is reversed to produce a climb cutting action and obtain a fine finish. The intake valve chamber is similarly machined on Snyder equipment, but with the table set to suit the different angle.

The faces of the intake and exhaust ports are rough and finish milled on two-spindle Cincinnati profile millers on which the heads are loaded two at a time, locating on flange and dowel holes and clamped through intake and exhaust valve guide holes by plates bearing on the rocker box faces. End mills machine port faces and adjacent sides of head, movement being controlled by a master template. After intake port face has been machined, tracer is shifted to a second template for machining exhaust port faces. Dry carbide tipped cutters are used.

Intake and exhaust ports are milled out to valve chambers. A high speed



Fins on curved upper surfaces are milled by Cincinnati machine which holds eight heads at one time.



One of first experimental machines for cutting fins on forged cylinder heads. Cutters runs at speeds approaching those used in woodworking.

Cincinnati Hydro-tel profiling machine was designed for this purpose, and is equipped with three individually powered spindles each driven by a high-cycle motor to rotate at 6,900 rpm., power for which is provided by a high cycle converter. The spindles are inclined at an angle of 15 deg. from the vertical, but feed is vertically downward. Three heads are located at one time by hardened blocks fitting the rocker box slot.

As the spherical cutters feed down into the work they travel in an approximately circular path, being controlled by a ball ended tracer operating in the master form. The curved passage thus generated is remarkably clean and requires only a smoothing operation with abrasive cloth to remove tool marks and blend it into the opening of the valve chamber. Approximately 15 min. are required to perform the operation on the three heads for the exhaust ports, and a similar time for the intake.

Milling out the fins is done by Cincinnati milling machines designed for the job by Wright and Cincinnati engineers. A standard mill was modified by reducing the load on the feed screws to less than five pounds by means of weights and pulleys. Two Keller attachments were connected to the table, one for the vertical movement and one for the horizontal, to follow a master profile, and thus the first heads were successfully produced. Considerable trouble was encountered with the cutters. Gang milling was tried unsuccessfully and standard milling saws were found to be entirely unsuitable since their harmonic frequency produced fractures. Special cutters were designed, vibration was dampened and excitation no longer occurred. Thirteen inches in diameter, equipped with nine finely finished carbide tipped teeth, these cutters produce an exceptionally good finish when operating at a surface speed of 4,500 fpm. and a feed of 70 in./min. Heat generated is virtually negligible, and both cutter and work piece remain sufficiently cool to be handled without difficulty.

When first installed it was believed the

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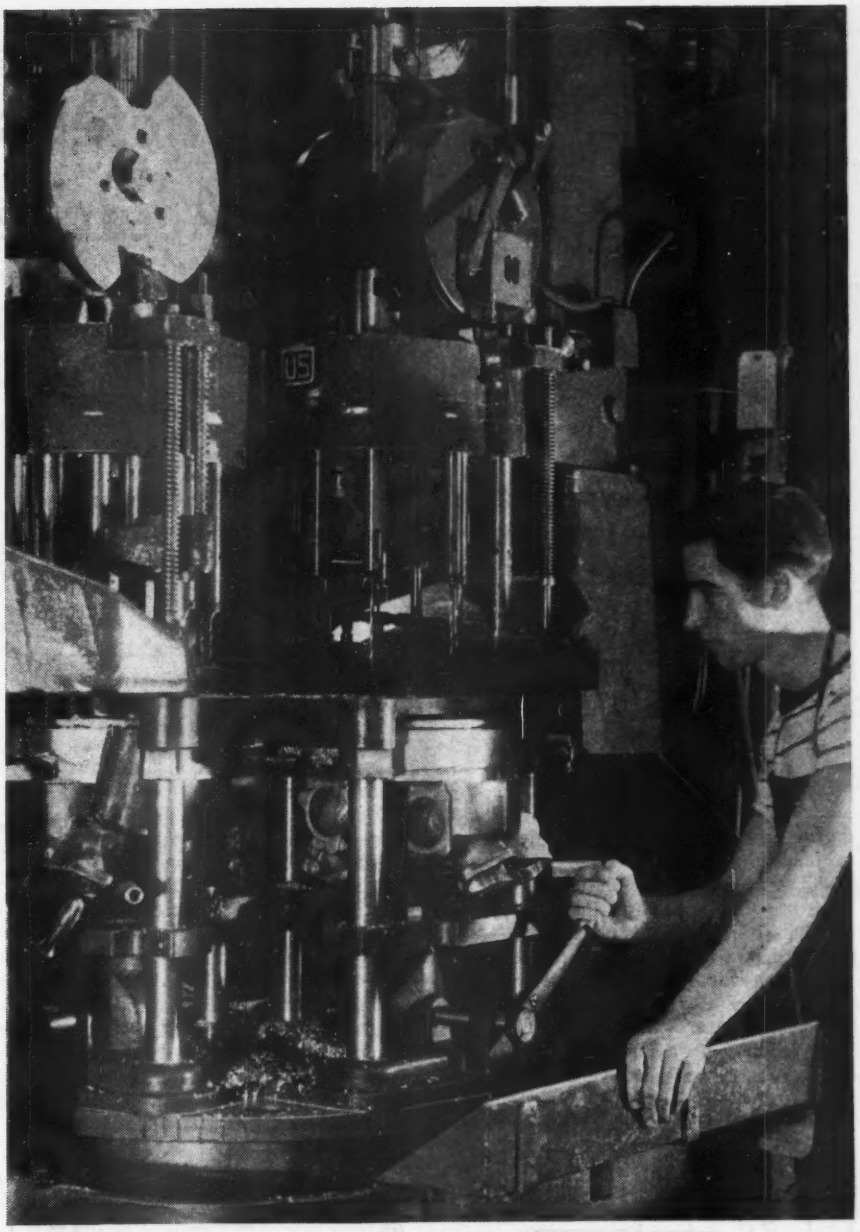
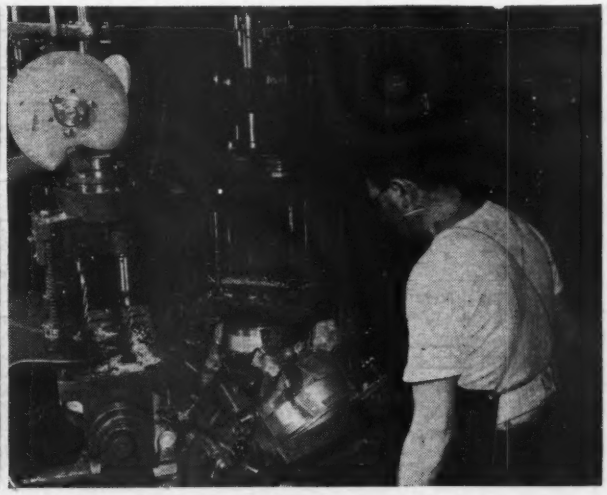


With three heads and four-position indexing table this Allen drill drills, re-drills and reams eight holes for fin bracing tubes.

Slots for fin braces are cut on this Snyder milling machine using several independent electric motors.



Allen drill equipped with specially designed turnover fixture locates, drills and reams dowel holes.

Load Characteristics Of Cellulose Acetate Plastic

PART I

By **WILLIAM N. FINDLEY** *Assistant Professor of Theoretical & Applied Mechanics, College of Engineering, University of Illinois*

Wide application of cellulose acetate plastic in aviation have given rise to further comprehensive studies of their load resisting properties. This series presents an exhaustive analysis of particular interest to designers and engineers.

CELLULOSE ACETATE is widely used both for civilian goods and in military applications. Typical military applications are transparent airplane cockpit enclosures, gas masks, oil cans, airplane control knobs, high impact resistant flashlight cases, and fire-resistant photographic film. Mechanical strength and toughness are the outstanding characteristics of cellulose acetate which have indicated its use in such applications.

In order to obtain more complete information on the mechanical properties of cellulose acetate and to determine the effect of certain variable conditions involved in service and testing technique, the tests described here were undertaken.

The following mechanical tests will be considered in the present discussion: "Static" strength tests in tension, compression, and torsion, also fatigue tests and creep tests. Some of the variables whose effects were studied include the effect of speed testing in both static tests and fatigue tests, the effect of moisture content, the effect of range of stress in fatigue, the effect of stress on the creep in tension, and the effect of moisture content (humidity).

Tests have shown that several factors which are unimportant in the testing of metals must be controlled during tests of cellulose acetate and most other plastics. Among these are small changes in temperature, relative humidity, and speed of testing. The effect of temperature and humidity was so serious that all tests had to be conducted in a laboratory especially constructed to provide constant temperature (77°F) and constant relative humidity (50 percent). Many of the tests also required the development of special machines and instruments, since available equipment was unsuited to tests of this material.

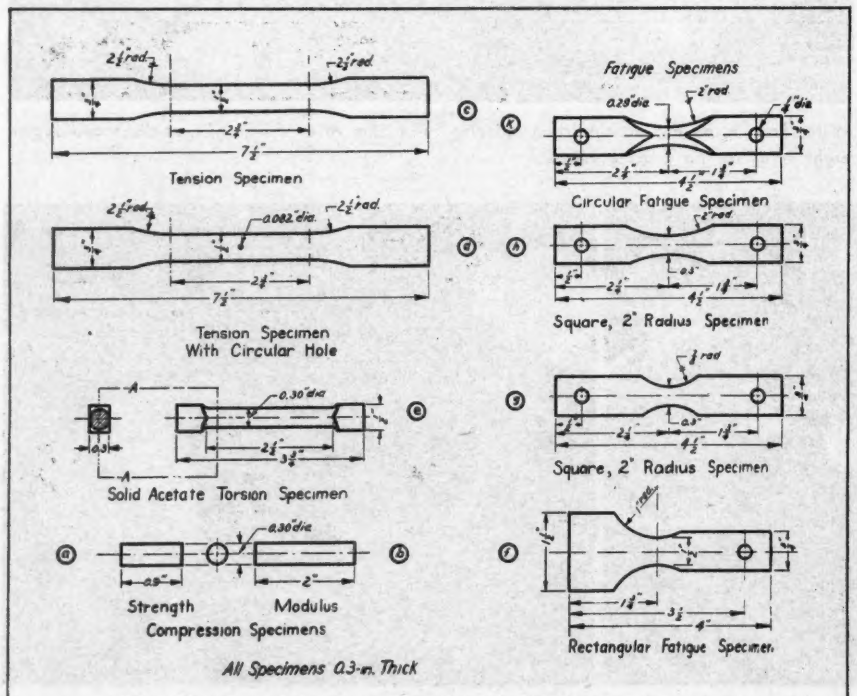


Fig. 1. Tests specimens in shapes attained after forming from sheet.

Materials and Specimens

The cellulose acetate plastic for these tests was supplied by the Plastics Div., Monsanto Chemical Co. The material was a clear, transparent thermoplastic composed of medium viscosity cellulose acetate of the acetone soluble type, plasticized with about 26 percent of phthalate and aromatic phosphate ester plasticizers. The Monsanto formulation number was 2050 TV.

All specimens used in these tests were cut from the same sheet of cellulose acetate plastic. This sheet was 0.3-in. thick and was made by the sheeter process, at a molding temperature between 200° and 250°F. The finished sheet contained less than 1 percent of residual solvent and water, and it had a Rockwell hardness of about L40 at 77° F., 50 percent relative humidity.

A drawing of the specimens used is shown in Fig. 1. All specimens were machined with the longitudinal axis parallel to the short side of the original sheet. The specimens were cut from the sheet on a jig saw, then milled or turned to the shape shown in Fig. 1. Machined edges were then smoothed by hand with No. 00 emery paper so as to remove all burrs and scratches, leaving the final polishing marks parallel to the axis of the finished specimen.

The compression specimens were not smoothed after machining because of the fact that slight surface scratches would not affect the results, inasmuch as the material did not fracture under a compressive load. All specimens were conditioned by allowing them to remain in the atmosphere of the testing laboratory for a period of at least two weeks prior to the start of the tests, and they were kept in the laboratory continuously thereafter. The laboratory was maintained at a constant temperature of 77° ± 1 F. and 50 ± 2 percent relative humidity continuously throughout the duration of the tests.

As for the effect of rate of strain on tension compression, and torsion tests:

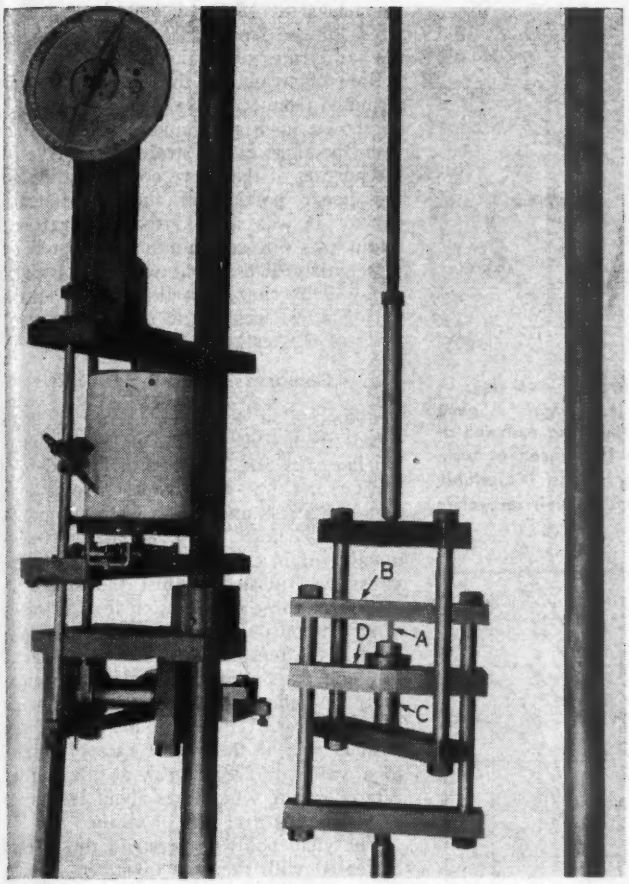


Fig. 2. Universal testing machine, used for compression, tension, and torsion tests, is equipped for variable speeds by series of V-belt drives. Rigged for compression tests (as seen here), a compression tool is employed to avoid possibility of eccentric loading of test specimens. The specimen A was compressed between the upper platen B and the cylinder C. The cylinder was guided in the yoke D so that the cylinder face was always parallel to the upper platen. Thus, if precautions are taken to machine specimen ends parallel and to center the specimens eccentric loading will be negligible.

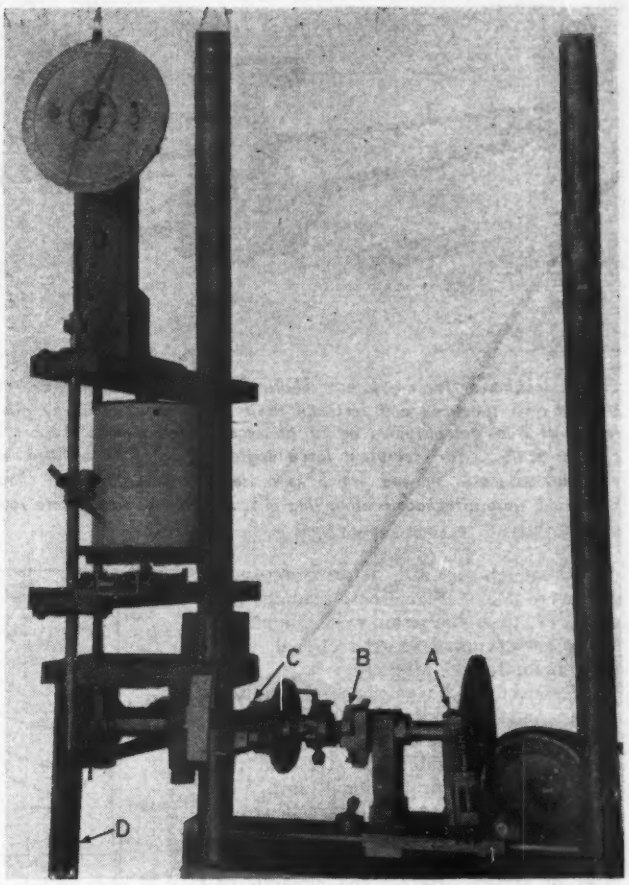


Fig. 3. Special apparatus used for torsion testing. The pendulum weighing system of the tension testing machine was used as the torque-measuring device, this being accomplished by attaching a twisting head A driven by a double worm drive. A special chuck B was attached to the twisting head shaft, and another chuck C was fitted to the axis of pendulum D. These chucks were designed to apply a torque to specimen with little danger of bending specimen at same time. This was done by mounting specimen on centers and applying torque as a couple by means of adjustable screws.

Static tension, compression, and torsion tests were made on specimens of the shape shown in Figs. 1c, 1b, and 1e, respectively. These tests were performed in the universal testing machine shown in Figs. 2 and 3.

Compression tests were made on specimens 2-in. long and of about 3/10-in. dia., so the 1/r ratio* was about 27. This length of specimen was necessary in order to accommodate the compressometer. The compressometer had a gage length of 1 in. and consisted of a 1-to-1 lever to which was attached a dial registering in one-thousandths. The instrument was attached to the specimen by means of pointed screws on opposite sides of the specimens, so that the strain measured was the average strain in the specimen.

Compression tests performed on the 2-in. specimen were used to determine the modulus of elasticity and shape of the stress-strain diagram in compression. A still longer specimen would be desirable to increase the accuracy of strain measurement. Effect of buckling would, however, become more serious with longer specimens. In order to obtain values of compressive yield strength, a shorter specimen, about 9/10-in. long, was used.

The l/r ratio for the short specimen was about 12. The yield point observed with the short specimens was 4,900 psi. at a rate of strain of about 0.002 per minute.

Special apparatus was designed and built for torsion testing of plastics because machines of low capacity were not available. The apparatus used is shown in Fig. 3.

Shearing strain (in the torsion test) was measured by means of the instrument shown in Fig. 4. This instrument measured the angle of twist of the specimen and was designed to accommodate materials whose ultimate shearing strain was relatively small, also materials which might twist two or three revolutions in a length of 2 in.

Torsion tests differ from tension and compression tests in two important respects. They differ in respect to the state of stress developed and in respect to the stress gradient. State of stress may be defined in terms of the ratio $\sigma_{max.}/\tau_{max.}$, i.e., the ratio of the maximum tensile stress to the maximum shearing stress at a point in the stressed member. In a tension member, this ratio is 2, while in a torsion member it is 1. Thus it may be that some materials will behave much differently in the two tests.

Stress gradient is a measure of the distribution of stress over the cross section of a member and is equal to the slope of the stress distribution curve—

$$\frac{d\sigma}{dy}$$

It has a value of zero in a tension member, but it can never be zero in a torsion member. Magnitude of the stress gradient in a torsion member depends on the stress and the size of the member and for elastic stresses is equal to—

$$\frac{\sigma}{r}$$

where r is the radius of the cross-section of the specimen. If the measured strength of a material is influenced by the stress gradient, then results may be obtained from the tension test differing from those of the torsion test.

Tension Test Results

The tension tests were performed at three different head speeds ranging from 0.021 to 0.32-in. per minute. During the

*l/r refers to ratio of length of specimen to radius of gyration of cross section of specimen.

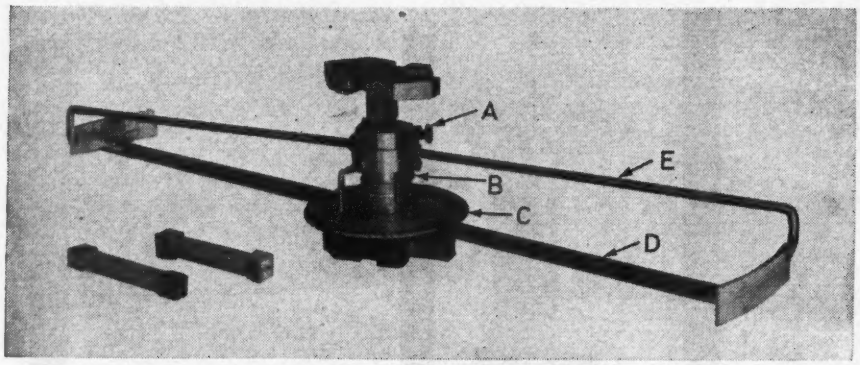


Fig. 4. Instrument for measuring shearing strain (in torsion tests) consisted of two rings A slipped over specimen and fastened to it by three adjusting screws in each ring. A gage length of 2 in. was obtained by use of removable spacer B. To one of rings was fastened at circular scale C for measuring large angles of twist. Two 10-in. arms D fastened to same ring carried scales, on end, which were used in measuring small shearing strains. Adjustable pointers E were attached to other ring in such a way as to indicate readings on their respective scales.

tests, readings of load, deformation, and time were taken. From these readings the values of stress and strain were computed, using the original cross-sectional area for computation of stress.

Fig. 5 shows the tensile stress plotted against tensile strain for these three tests. It is evident that the higher rates of strain produced higher values of stress in the region beyond the proportional limit. The diagrams plotted to an enlarged strain scale (Fig. 5) indicated that the modulus of elasticity was the same for all three rates of strain. Herein the modulus of elasticity is designated as the ratio of stress to strain at the initial portion of the curve and is measured as the slope of the initial straight line portion of the curve.

The value obtained in the tension test was 244,000 psi. The upper yield point was designated as the stress corresponding to position *A*, Fig. 5. The upper yield point varied from about 3,500 psi., at a rate of strain of 0.0016 per min., to 4,400 psi. for a rate of strain of 0.04 per minute. The lower yield point *B*, Fig. 5, ranged

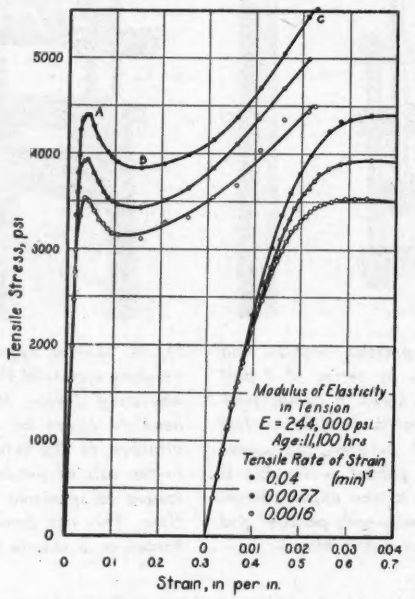


Fig. 5. "Static" stress vs. strain in three tension compression tests.

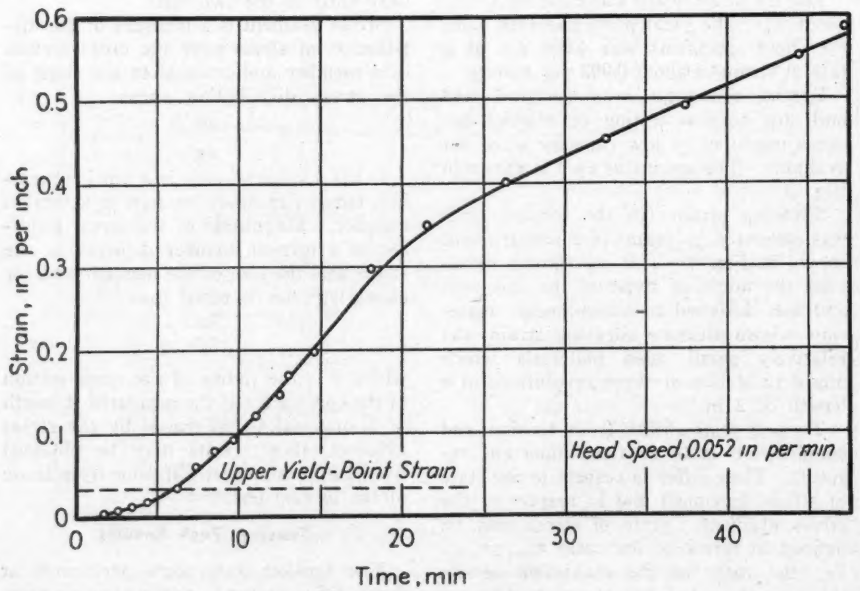


Fig. 6. Strain vs. time in tension.

from 3,200 to 3,800 psi. and the fracture stress ranged from 4,500 to 5,500 psi. for the same rates of strain given above.

Rate of strain for these tests was determined from strain vs. time curves such as shown in Fig. 6, and was computed from the slope of the strain-time curve in the portion of the curve corresponding to the linear portion of the stress-strain curve. It was noticed that the rate of strain was not constant but consisted of three fairly distinct but separate straight lines. This change in the rate of strain during a test was due in part to the elasticity of the testing machine.

Compression Test Results

Compression tests were run at head speeds from 0.008 to 0.13 in. per minute. During each test, readings of load, deformation, and time were taken. From these data the stress and strain were computed using, as before, the original cross-sectional area in computing the stress. The stress was plotted against the strain in Fig. 7 for three compression tests at rates of strain approximately the same as those used in the tension test. It was observed in these tests that the modulus of elasticity, as defined above, was not the same for all rates of strain but increased from 204,000 psi., at the lowest rate of strain, to a value of 278,000 psi. at the higher rate of strain, which was about ten times as fast as the first rate of strain.

The yield point observed in these tests increased with the rate of strain from a value of 3,400 to 4,300 psi. Rate of strain for the compression tests was determined from strain-time diagrams similar to that shown in Fig. 6, and the rate of strain was determined in the same way. The strain-time diagrams for compression tests were similar to those for tension, except that the test data were not obtained much beyond the yield point.

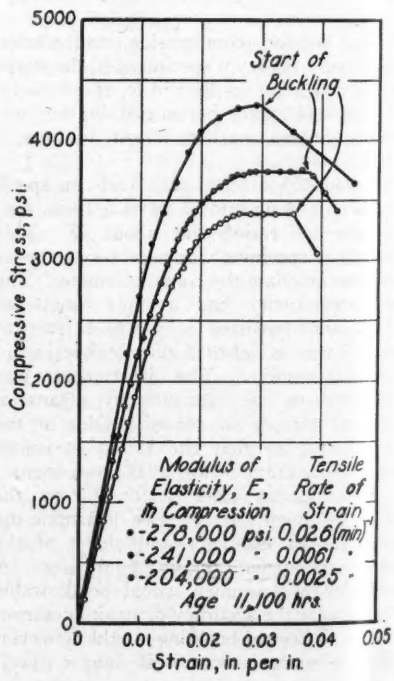


Fig. 7. "Static" stress vs. strain in three compression tests.

Torsion Test Results

Torsion tests were performed at three different head speeds, ranging from 0.017 to 0.33 rpm. During these tests, simultaneous readings of torque, angle of twist, and time were taken. The shearing stress at the surface of the cylindrical specimen was computed from the equation—

$$\tau = \frac{Tc}{J}$$

and the shearing strain was computed from the relationship—

$$\delta = \frac{c\theta}{l}.$$

It is recognized that the equation used for Δ does not give the actual stress, except for stresses below the proportional limit. However, for comparison of the relative strength of the material under different conditions the equation is sufficiently exact. Shearing stress, as discussed above, plotted against the shearing strain is shown in Fig. 8 for three different rates of strain. Shearing modulus of elasticity, found to be the same for all three rates of strain, had a value of 78,300 psi. Values of shearing stress increased with the rate of strain, just as observed in the tension and compression tests.

The upper yield point *A*, Fig. 8, increased from about 2,600 to 3,300 psi., with increase in rate of strain; the lower yield point increased from about 2,500 to 3,000 psi.; and the torsional modulus of rupture increased from 4,300 to 4,900 psi. Rates of strain were determined from strain-time diagrams, such as shown for tension tests in Fig. 6, and were computed from the slope of the curve which obtained during the linear portion of the stress-strain curve.

In order to compare values of shearing strength with values of tensile and compressive strength, equivalent rates of strain were used for all tests. In order to accomplish this, the rate of tensile strain was kept the same for all three types of test. The maximum tensile stress occurring in a torsion member is equal to the maximum shearing stress so that the tensile rate of strain can be computed from the shearing rate of strain by the relation—

$$\frac{\epsilon}{t} = \frac{\delta}{t}\frac{G}{E}$$

where ϵ/t is the tensile rate of strain, Δ/t is the shearing rate of strain, and G/E is the ratio of shearing modulus to tensile modulus. It was decided to use equal tensile rates of strain rather than equal shear rates of strain, because the material fractured along planes of maximum tensile stress under the conditions of loading studied.

Comparison of Test Results

A comparison of the results of the three different tests shows that the upper yield points in tension and compression (long specimen) were approximately the same. However, the yield point obtained with the short compression specimen was about 40 percent higher than the upper yield point in tension. The upper yield point in torsion was about ¾ of that tension. In the compression test, no difference was observed between upper and lower yield points. The difference between upper and lower yield points in torsion was much less than that in tension. The total strain required to rupture a specimen in torsion was 50 percent greater than that required to rupture a tensile member, whereas for compression, rupture did not occur at all for very large strains.

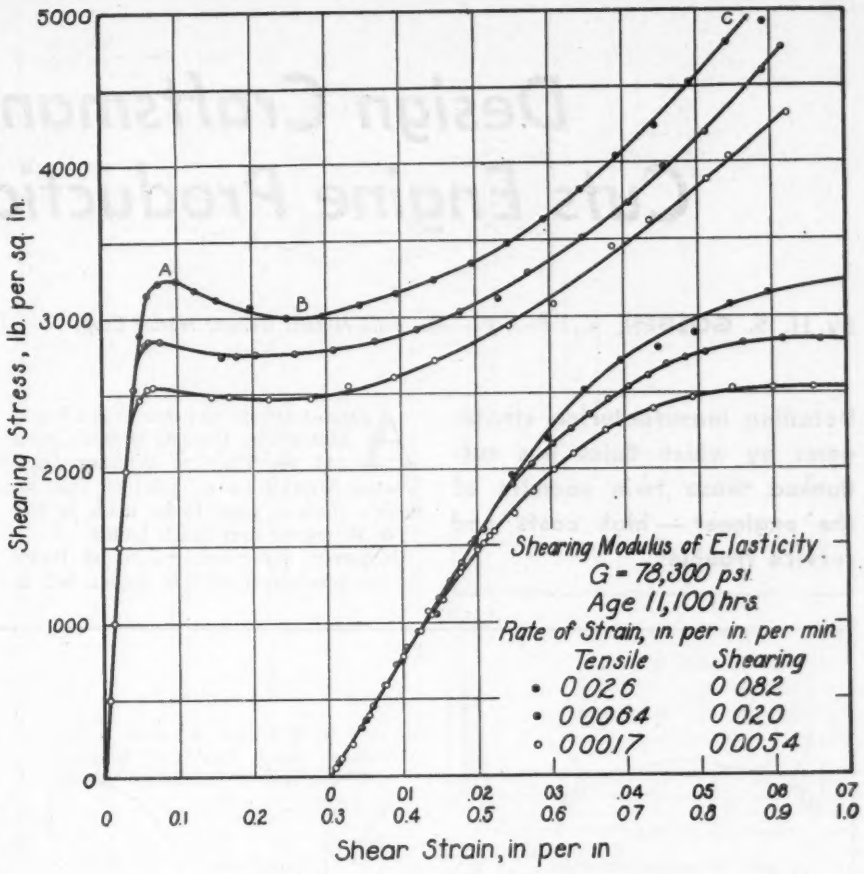


Fig. 8. "Static" shearing stress vs. shearing strain in torsion.

A considerable ductility of material was shown in all tests, as evidenced by maximum strains of the order of 40 to 50 percent in tension. However, the fractures were those characteristic of brittle material, as usually thought of from the standpoint of metals. That is, fracture occurred as a result of separation along the plane of maximum tensile stress, a plane perpendicular to the axis of the

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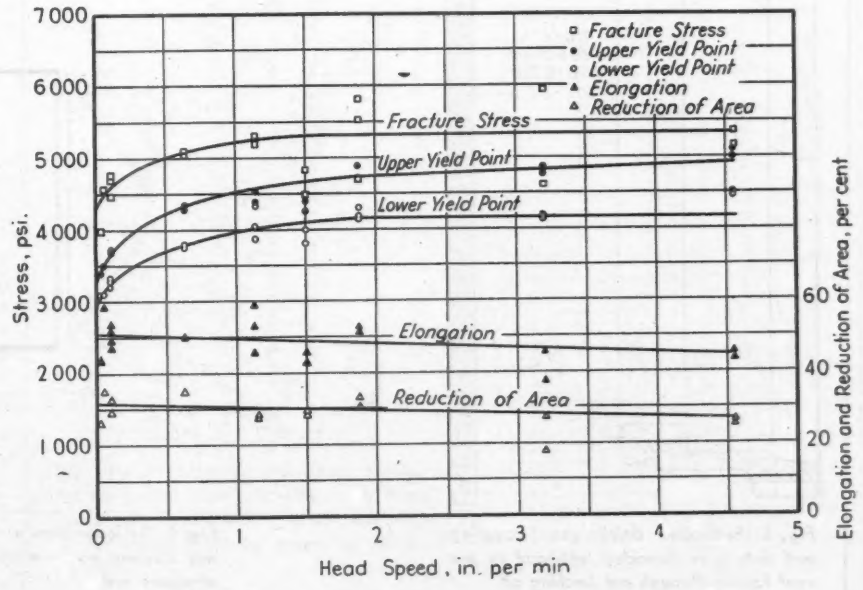


Fig. 9. Effect of speed of testing on tensile properties.

Design Craftsmanship Cuts Engine Production Costs

By **H. S. GOLDEN,** *Ass't Chief Engineer, Buick Motors, General Motors Corp.*

Detailing manufacturing strategems by which Buick has outflanked those twin enemies of the engineer — high costs and service troubles.

ARRANGEMENTS between the Buick Motor Div., General Motors Corp., and the Pratt & Whitney Div., United Aircraft Corp., specified that no design changes were to be made in the P & W engine that Buick builds.

However, experience gained by Buick in the production of this engine led to certain seemingly minor design changes agreed to by P & W engineers that have had a marked effect—either in reducing production costs, in avoiding service troubles, or both. Several such instances are outlined in this article.

Fins of the cylinder head around the sparkplug opening were giving trouble from breakage at critical speeds, the vibration causing this breakage being set up by air currents passing between the fins. To overcome this difficulty, the

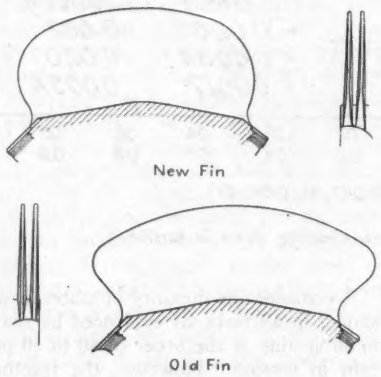


Fig. 1. By redesigning fins around sparkplug openings, breakage was eliminated.

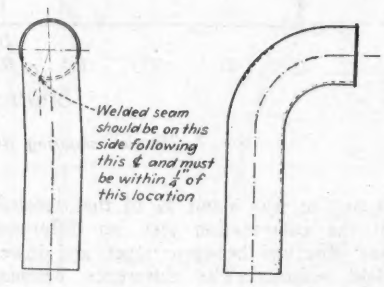
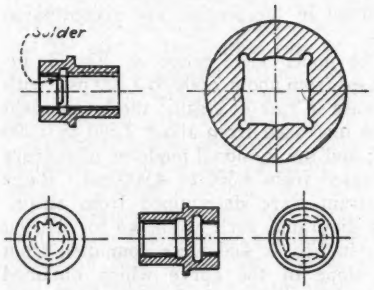


Fig. 2. Intake elbows are welded instead of being bent from seamless tubing.



Figs. 3 and 4. Two-part soldered fuel pump coupling (top) was replaced by solid part (right).

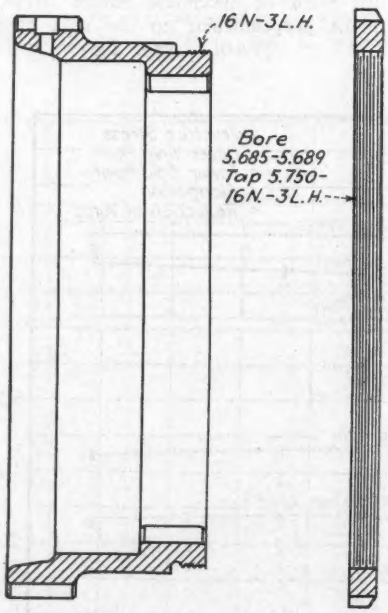


Fig. 5. Reduction drive gear couplings and nuts were threaded left-hand to prevent failure through nut backing off.

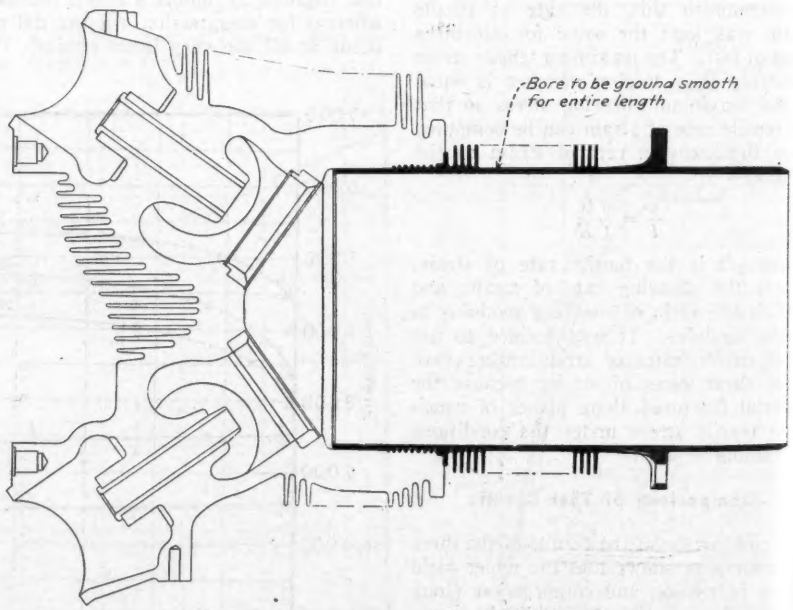


Fig. 6. Cylinder bore was ground after head (left) was screwed on, thus eliminating former "choke" at upper end.

contour of the fins was altered to decrease length and the sectional area (thickness) was slightly increased near the base of the fins where fillets are joined and meet the body of the casting (as shown in Fig. 1). This changed the critical period and eliminated breakage without altering performance in other respects.

Furthermore, specifications formerly required that intake pipes, which include a 90-deg. elbow, should be formed from seamless steel tubing. When the supply of such tubing became greatly restricted, Buick secured permission to employ a welded seam tube (as shown in Fig. 2). This is made on a continuous resistance-type electric seam welding machine formerly employed by Buick in making exhaust tubing for passenger cars. The welded tubing is cut to length and bent in a special machine. Subsequently, the elbows are sized inside by clamping in a die while steel balls are forced through by the ram of a press. Weld flash is completely removed. This method of manufacture has considerably reduced costs, besides avoiding a critical material shortage, and it has had no adverse effect upon engine performance.

The fuel pump coupling was changed from the two-piece design shown in Fig. 3 (where the parts were joined by soldering) to a one-piece design (Fig. 4) in which, of course, no soldered joint is needed. It was formerly thought that a part such as that in Fig. 4 would be impractical to manufacture, but Buick developed a new manufacturing technique by which it is produced as shown. This results in a part that cannot give the trouble from leakage, sometimes encountered before.

Reduction drive gear couplings and mating nuts formerly had right-hand threads. Failure of both the bearing gear and other gears in the nose section had resulted because the nut had sometimes loosened and backed off. Such failures have now been eliminated by changing to a left-hand thread in which the tendency is for the nut to tighten rather than to come loose. Fig. 5 shows the coupling and nut in their present form with left-hand threads.

Variations in the choke dimensions at the end of cylinder bores were considerable when this portion was ground before the cylinder head was screwed and shrunk on. Now, the grinding is done after the heated head is screwed on, and the head shrinks to the barrel. As a result, variations are only slight, and the amount of honing required is greatly reduced, lowering costs accordingly (Fig. 6).

Formerly, oil control rings on pistons were made with a radius at the lower portion of the outer diameter. It was not too easy to hold the specified radius and, when it was held, the width of the land or bearing surface left was 0.035 to 0.045 in. By changing the radius to a chamfer made at an 18-deg. angle (as shown in Fig. 7) the land width is decreased to hold the limits 0.025-0.035 in. This narrower land results in increasing the unit pressure of the ring against the wall of the cylinder and enables the

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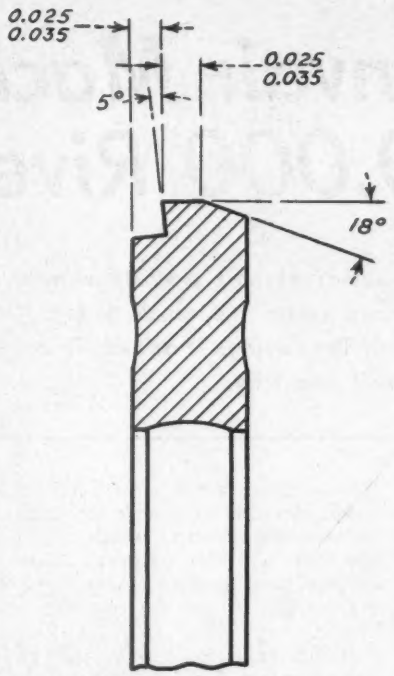
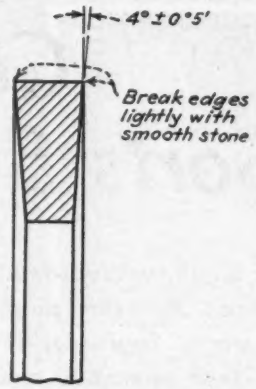




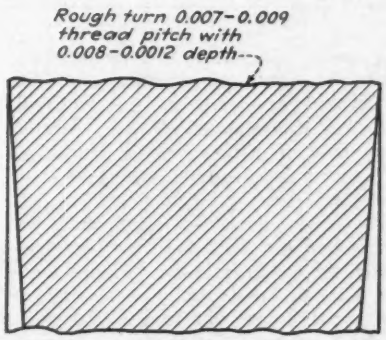


Fig. 7. Radius on bottom of oil rings was changed to 18-deg. angle, resulting in greatly decreased oil consumption.

Fig. 8. Outside of compression rings was turned with fine thread, which holds oil and results in shorter "setting" time.

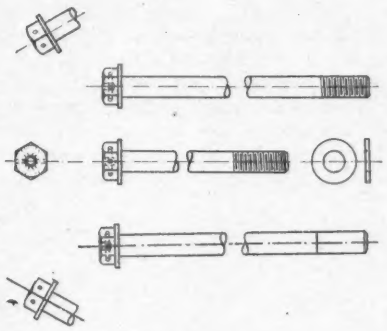
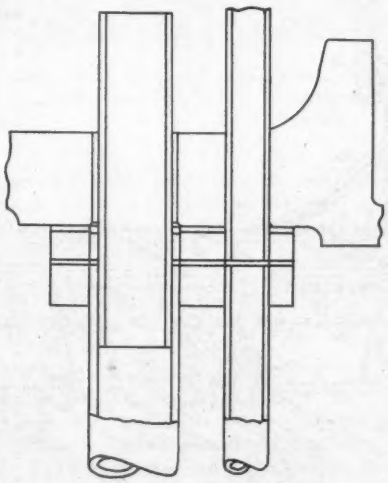


Fig. 9. Bolt (left, top) was formerly built up as shown in center. Lower bolt was upset from rod, saving much work in manufacture.



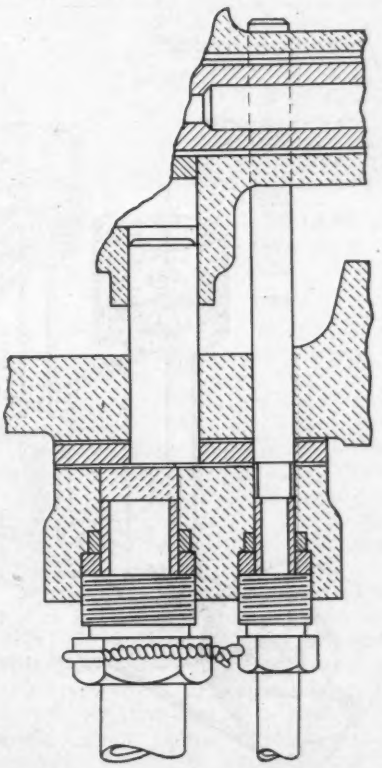


Fig. 10. Oil pipes (above) gave trouble from vibration breakage. This was entirely cured by installation (right) providing elastic connections by means of plastic washers.

Convair Machine Sorts 50,000 Rivets Hourly

When this ingenious dual-feed mixed-rivet unit was developed at Consolidated's Nashville plant, there came the quick order: "Put it right to work." Figure for yourself the savings it affords in every-day-of-the-year operation and you'll see why.

A NOVEL AND HIGHLY EFFICIENT machine for sorting mixed rivets has been developed at the Nashville Div. of Consolidated Vultee Aircraft Corp. Creator of the device is Harold O. Mills, who first made an extensive study of the problem.

This new dual-feed rivet unit will handle two different diameters simultaneously, sorting them in the complete range of lengths at high speed. It is estimated that each hopper will feed 25,000 rivets per hour, making a total sorting capacity of 50,000 rivets per hour. A single ½ hp. motor drives the complete assembly, and it is to be noted that no air pressure is used.

Details of the mechanism are revealed in our accompanying plate of cutaway sketches. Referring first to Fig. 1, the two feed hoppers (1) are mounted at the back of the machine, one on each side of the conveyor assembly (2) and at sufficient elevation to provide the necessary incline to the delivery channels (3) so that the rivets will slide by gravity from the hoppers through these channels and into the notches (4) on the conveyor plates (5).

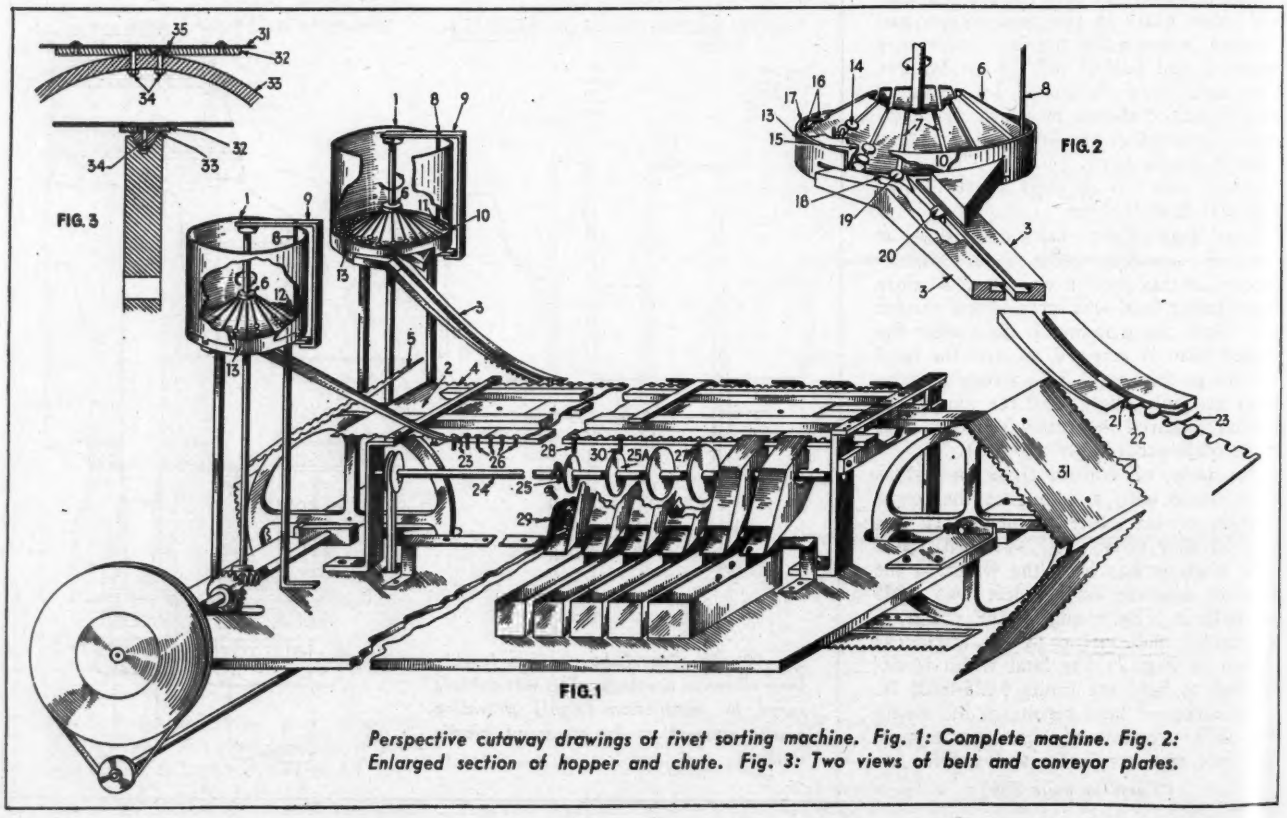
Within each feed hopper is a rotating conical segment (6) which is provided with radial feed slots (7) of sufficient width to allow a free sliding fit for the shank diameters of the rivets, but not wide enough to permit the head diameters to enter.

The flexible agitator rod (8) extends from the support bracket (9) downward toward the segment (6) and near the stationary baffle rim (10) of the hopper. Enough clearance is allowed between the lower end of this agitator (8) and the surface of the segment (6) to permit the heads of the rivets (11) sliding down the segment slots (7) to pass under the agitator.

As the segment revolves, the mass of loose rivets (12) collides with the agitator (8), thus the rivets are prevented from riding undisturbed. The vibratory resistance of this agitator repeatedly disarranges the mass of rivets as it is carried past it by the revolving segment, and as the rivets are thus shifted in position a number of the shanks will drop into the slots of the segment.

Since the shank of a rivet is heavier than its head, and since the segment slots are not as wide as the head diameters, the rivets fall into the slots until supported by their heads, with the heavier shanks hanging downward. In this manner they slide down the inclined segment slots and underneath the baffle rim (10) until they are arrested by contact with the inner wall of the hopper base.

Now note the enlarged detail of the hopper mechanism in Fig. 2. It is seen that the baffle rim (10) encircles the segment (6) and its attached by its outer circumference to the inner wall of the hopper base (13). The surface of this rim is wide enough to cover the lower



Perspective cutaway drawings of rivet sorting machine. Fig. 1: Complete machine. Fig. 2: Enlarged section of hopper and chute. Fig. 3: Two views of belt and conveyor plates.

portion of the segment, as shown, and it is located parallel to the slanted plane of the segment, with enough clearance between for the thickness of the rivet heads to pass under. After the rivets (suspended by their heads in the segment slots) slide under this rim they are entirely freed from further interruption by the remaining mass of rivets, the weight of which is supported by the rim.

When the rivets become lodged crosswise (14) before sliding under the baffle ring the wedge-shaped extension (15) the upper edge of the baffle ring causes them to thrust upward from the path of their circular travel, and this disturbs them sufficiently to unclog the segment slot.

After they move down the segment slot until their heads (16) come in contact with the inner wall of the base rim (17) they continue in contact with this rim until the slot in which they ride carries them around to the delivery channel entrance (18).

At this point the space between the segment and the base rim gradually widens until there is clearance enough for a rivet (19) to leave the segment slot (17) and enter the delivery channel (20). This channel extends downward (lower portion, Fig. 2) into a plane parallel to the horizontal operating plane of the conveyor plates and near enough to the edge of these moving plates (21) to guide the rivets from the channel into the conveyor slots (22), where they are thrust snugly into position by the spring (23).

Should a rivet arrive at this point out of time with the slot, the spring (23) will yield until another slot comes into position to receive the rivet.

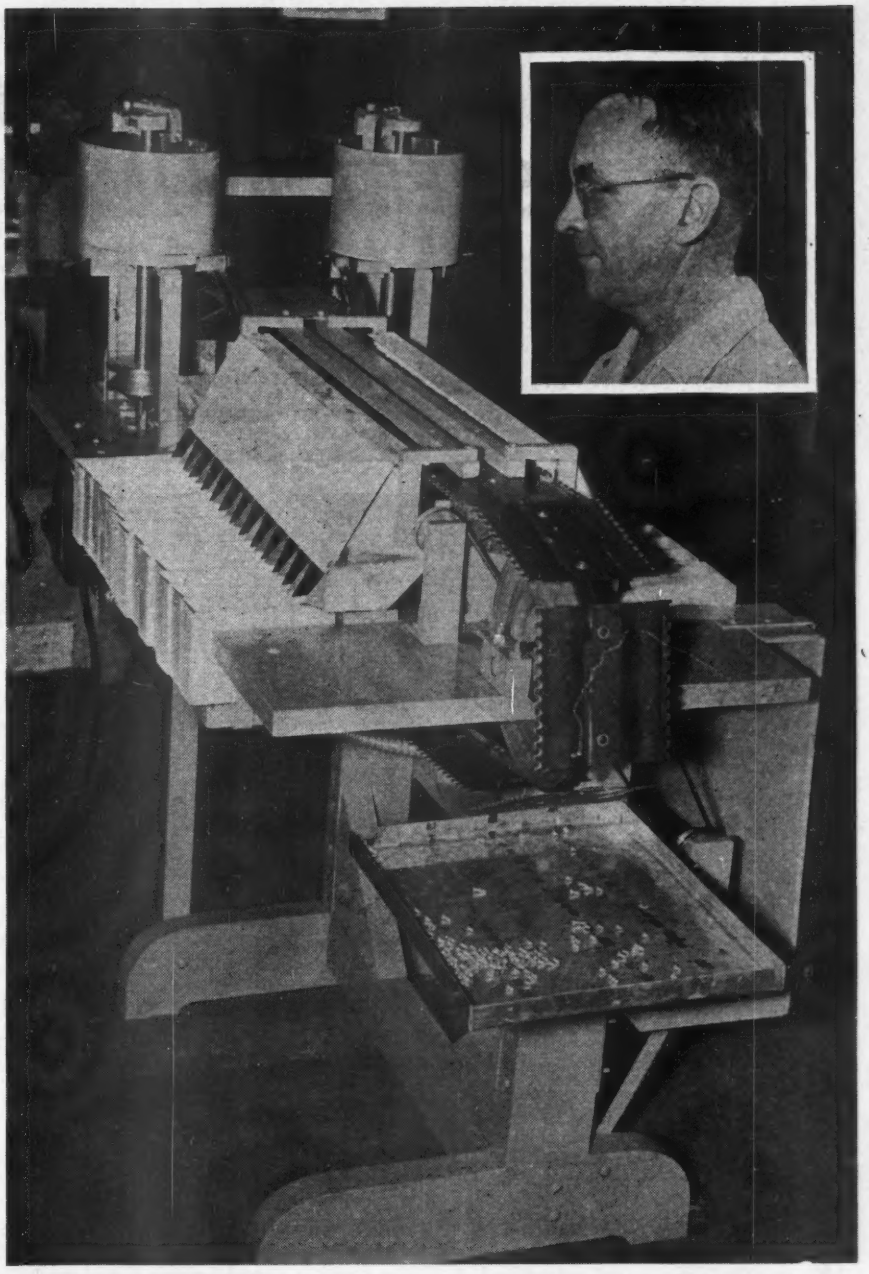
Returning to Fig. 1: On each side of the conveyor assembly (2) and parallel to its plane of movement is mounted a drive shaft (24) equipped with disks (25) of various diameters. The shaft is so located that its center line of revolution is below and parallel to the line of travel followed by the rivet shanks (26) which extend downward from the conveyor plate notches (22) in which the rivets are carried by their heads.

The difference in the diameters of the various disks (25, 25-A, etc.) corresponds with the difference in the lengths of the rivets, so that the distance from the outer rim of each disk to the conveyor plates is just sufficient to permit one particular length of rivet to contact that particular disk.

Since the upper surfaces of these rapidly revolving disks move at right angles (27) to the parallel plane in which the conveyor plates travel, the direction of thrust transmitted to a rivet by contact with a disk is outward from the notch in which the rivet hangs from the conveyor plate.

Therefore, as the rivet shank (28) comes in contact with the disk (25) it is thrust forward out of the notch and into the delivery chute (29). A size-shorter rivet (30) would pass over the disk (25) but would contact the next disk (25-A) and thus be delivered into a different chute.

In Fig. 3, which depicts a cross section of the belt and carrying plates, the conveyor plates (31) are attached to the



Fast-action rivet sorter set up in plant. Hoppers are seen in rear, sorting mechanism and bins in center, and reject pan in foreground. Inset: H. O. "Bud" Mills, inventor of the device.

support bars (32) which are fastened to a V-belt (33) by two bolts (34). One of these bolts is provided with a slide mounting (35) to allow for the flexing movement of the belt.

This diameter rivet sorter is of the gravity-feed, cradle-action type, and consists of the following major units:

Feed hopper: This is a part of the rocking unit and is provided with a short agitator lever just behind the feed slot through which the rivets slide into the cradle trough for separation. This agitator keeps the rivets from clogging by wiping in an arc across the floor of the hopper near the feed slot. It is connected by a shaft through the hopper floor to a parallel pendulum, which conveys motion to the agitator from the rocking action of the machine.

Cradle trough: This trough is attached to a center shaft which is mounted to slant, at an angle of 10 deg., from the hopper end down to the delivery end. An oscillatory drive mechanism causes this shaft to rock the trough sidewise in a 45-deg. movement. Rivets fed from the hopper are then shifted from side to side as they travel down the length of the trough to the end.

Separator combs: The bottom of the trough is divided into five sections, each of which has a bottom plate of equally spaced transverse slots mounted in the center and extending to the sides of the trough, like the teeth of a comb. The width of these slots is varied in each of the five sections to correspond to the

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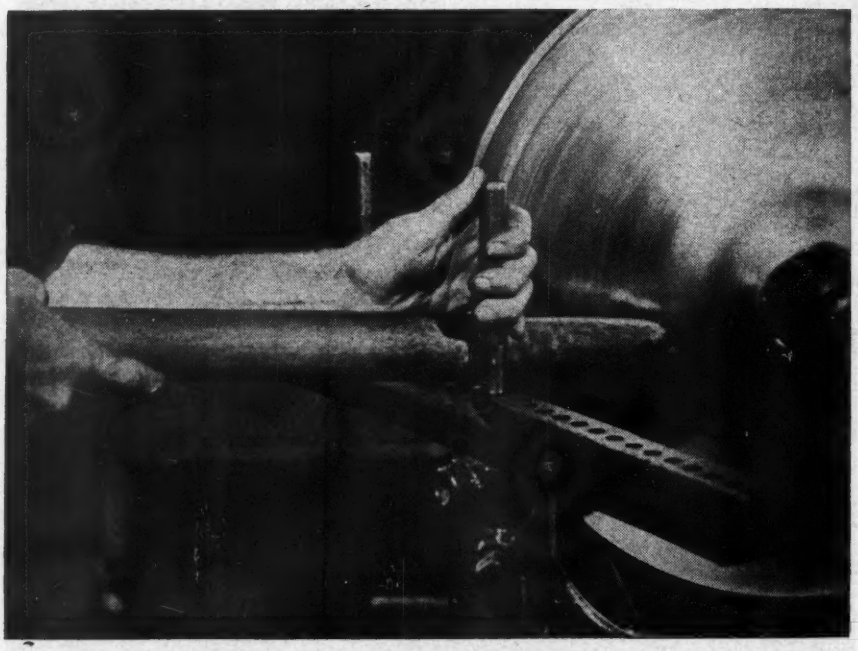
METHODS FOR FORMING SHEET ALUMINUM

PART II—SPINNING OF ALUMINUM

Specific examples showing ways of forming circular aircraft parts without resorting to the expense of dies or heavy drop presses.



Method of spinning sheet aluminum with hickory stick.

THE art of sheet metal spinning was developed by a small group of artisans in Europe and introduced in the United States about 1840 by a man named Jordan, who started a small shop in New York City. Through the years, the spinning of aluminum found most of its applications in the production of circular hollow shapes which could not be drawn because of design, or production where tool costs had to be kept low.

Today, spinning is largely an operation supplementary to drawing, in which the shell is first drawn and then necked by spinning.

In the spinning process, a lathe is used to rotate a metal blank at high speed while it is pressed against a rotating chuck of the form of which the blank is to take. The blank is forced against the chuck by means of tools, either manually or mechanically manipulated.

Spinning has advantages over some of the other forming processes in that the operator can feel the metal "flow" beneath the spinning tool. Tearing and breaking seldom occur since the experienced operator is able to judge the rate at which the metal is hardening.

Spinning lathes are similar in many respects to the lathes used for woodworking, although they are of heavier build. A larger headstock is necessary because of the great pressure exerted on it, and the bed of the lathe should be long enough to accommodate a wide range of lengths for a blank of given diameter, unless only shallow shells are to be spun. The tailstock screw should have a coarse pitch to facilitate removal of the shell after spinning.

Commercially pure aluminum (known as 2S) and some of the more ductile aluminum alloys may be formed into quite complicated circular shapes by spinning. The other aluminum alloys are not spun as easily as 2S, although the aluminum manganese alloy, 3S, because of its higher yield strength, is employed in the fabrication of a large number of spun articles. Occasionally 52S and the heat-treated alloys are spun, but they must be annealed frequently or spun hot. Whenever possible the softer tempers should always be employed in order to compensate for the strain hardening that takes place while the metal is being worked.

When it becomes necessary to anneal the metal before completing the spinning operation, a torch may be played on the partially spun article while it is rotating in the lathe. A soft pine stick rubbed across the metal will leave a brown char mark when the annealing temperature has been reached.

Heating with a torch will not fully anneal the metal. If it is necessary to fully anneal, the work should be removed from the chuck and heated to a tem-

Table I—Speeds for Spinning Aluminum Disks

Blank Dia. In.	Thickness of Metal, In.	Temperature of Metal, Deg. F.	Lathe Speed, RPM.
36 to 72	3/16 to 3/8	400 Max.	50 to 250
24 to 36	12 ga. to 3/16	Room	250 to 550
12 to 24	20 to 12 ga.	Room	400 to 700
Up to 12	20 to 16 ga.	Room	600 to 1,100

Left to right: Forming tool, trimmer, and beader.

The B.F. Goodrich Airline of the month

NORTHWEST AIRLINES

Long known for its fast service between Chicago and Seattle, Northwest Airlines, Inc., has branched out into other important activities since the war began. Currently employing more people than any other domestic airline, Northwest operates two Bomber Modification Centers for the Army. In addition, Northwest personnel were largely responsible for the establishment of the Army-controlled air route from Minneapolis to Alaska.

Many B. F. Goodrich products fly Northwest's routes. De-Icers help keep their planes in year-round operation. Silvertown tires mean smoother take-offs and landings. Expander Tube Brakes give Northwest pilots excellent ground control.

For their excellent record of service in both commercial and war activities we salute Northwest Airlines, Inc.—this month's "Airline of the Month."

In war or peace

B.F. Goodrich

FIRST IN RUBBER

NEWEST ICE PROTECTION DEVELOPMENT...

the electrically heated propeller shoe

Any pilot who has ever run into icing conditions without propeller ice protection knows why it's so vital to safe flight. Without it, ice forms on the blades, causing loss of propeller thrust, unbalance, and excessive engine vibration. Then, too, there is the danger and annoyance caused by ice flying off in large chunks and hitting the windscreen or fuselage.

It has long been felt that a blade covering which could be heated would be an efficient method of protecting propellers against icing. This type of ice preventer would be particularly well suited for use on long-range military aircraft.

Years ago, B. F. Goodrich engineers began development work on this type of blade covering. Today, the electrically heated propeller shoe is a reality . . . and it has performed amazingly well.

This new ice protection device containing synthetic rubber fits over and is cemented to the propeller blades' leading edges. It covers the area of the leading edge, where icing usually occurs. Electrical current from a generator (which may be mounted on the hub) produces heat in the shoe material. A special construction of the shoe concentrates heat directly at the leading edge, where ice protection is most vital. Efficiency is promoted by electrical and heat insulation at the blade side of the shoe.

The surface of the shoe is smooth, and conforms to the contour of the blade when cemented on. Thus there are no irregularities to upset airflow. Because the shoe keeps ice from forming, maximum thrust is preserved—unbalance and excessive engine vibration are minimized. The shoe also provides a highly abrasion-resistant covering for the blade.

For more facts about this new electrically heated propeller shoe, write to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

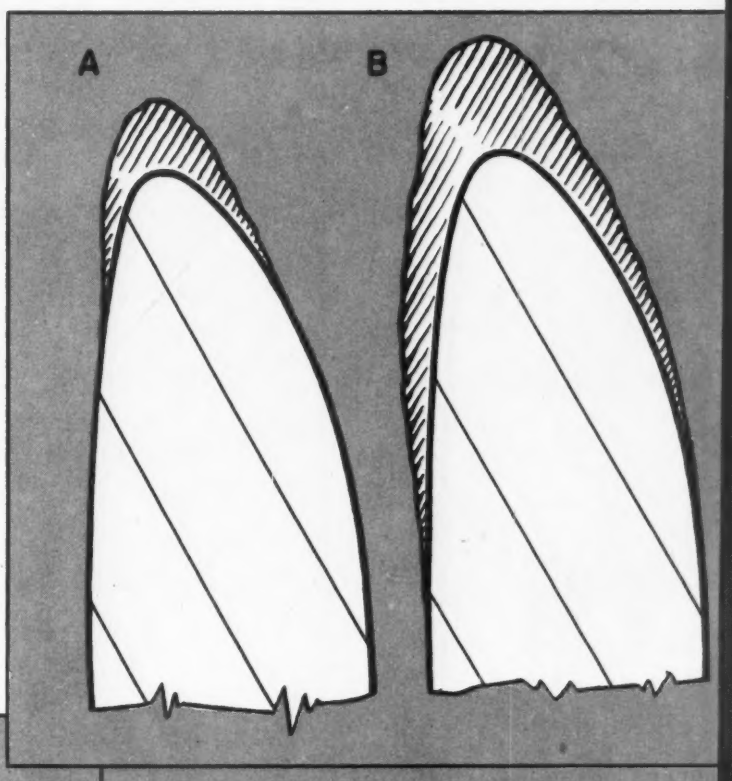
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

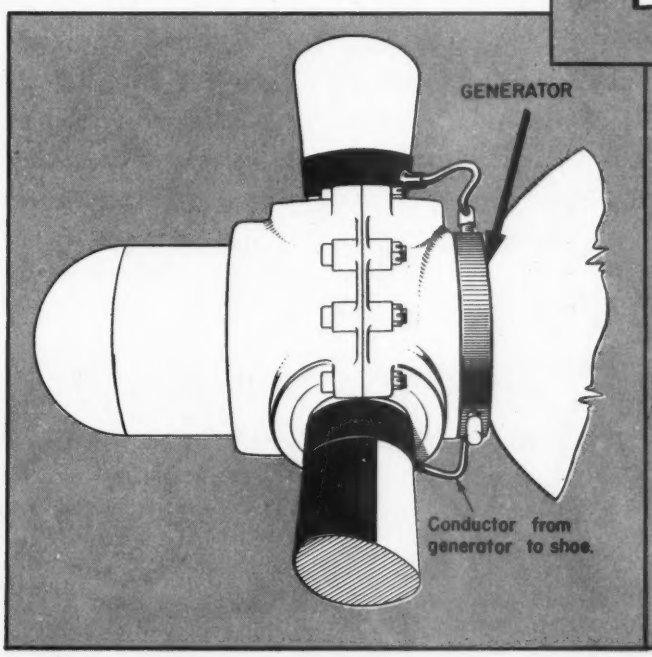
ARMY E NAVY

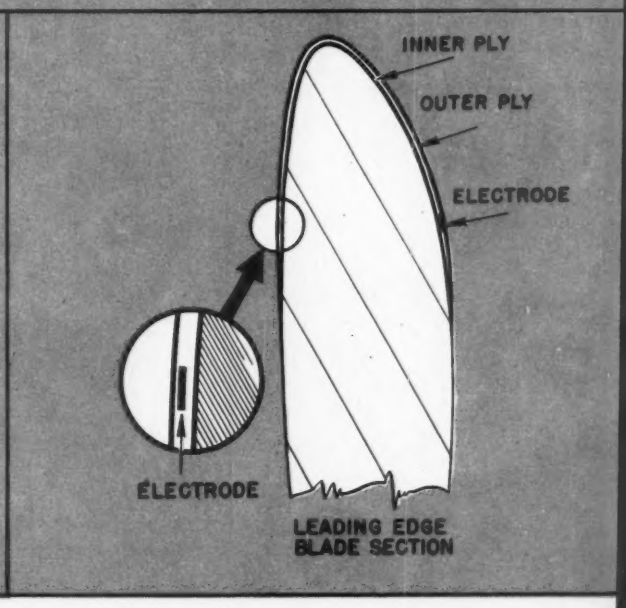
HEAT CONCENTRATION AT PROPELLER LEADING EDGE

increases efficiency at lowest temperatures

Scores of test flights led to the development of a means of concentrating heat across that part of a propeller blade's leading edge, where ice forms under severest flight conditions. In sketch A at right, is shown the way ice often forms under coldest temperatures. Note heavy concentration of ice at extreme edge. Sketch B indicates the greater area covered by ice under warmer conditions. This ice, being softer, melts at lower temperatures.







Simplicity keynotes the operation of the heated propeller shoe, as demonstrated in the sketch above. Note the location of the hub generator, which connects with electrodes in the shoe.

Cross section of a heated propeller shoe (right), showing the heat concentration area and the insulation, which minimizes heat and current loss into the propeller blade.

In war or peace

B.F.Goodrich

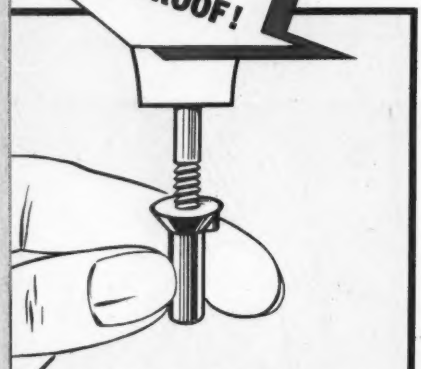
FIRST IN RUBBER

INSTALLATION IS SIMPLE, FAST, FOOLPROOF!

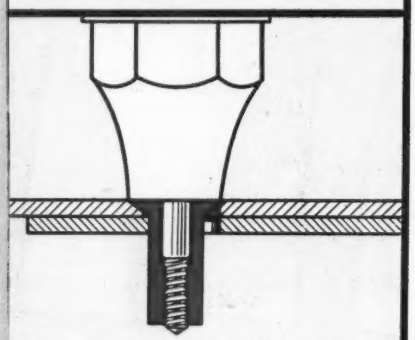
RIVNUTS

ARE IDEAL FASTENERS FOR...

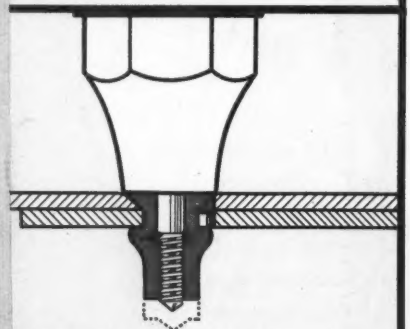
- fillets and fairing
- door and window frames
- access panels
- flooring and upholstery
- wing panel closures
- bonding wires
- clips, brackets, etc., for conduit
- panel board fixtures
- light frames
- plastics



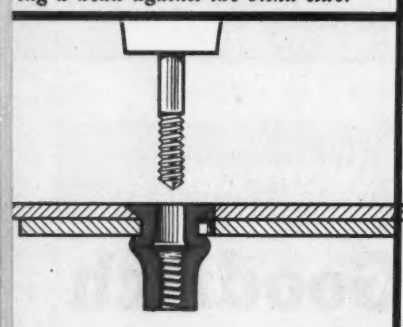
Thread Rivnut onto "pull-up" stud until head of Rivnut touches anvil of heading tool.



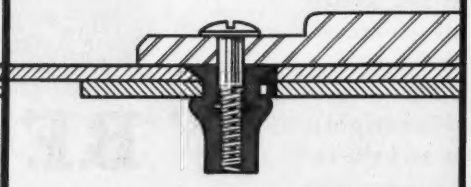
Insert Rivnut into hole. When Rivnut with key is used, be sure the key is indexed to enter the keyway previously cut in metal.



With tool at right angle to work, squeeze lever. This retracts "pull-up" stud into tool, which causes counterbored portion to bulge, forming a head against the blind side.



Unscrew "pull-up" stud, leaving threads of Rivnut intact and ready



5. *Attaching accessory with screw is*

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RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

perature of 650 to 750 deg. Immersion in a molten nitrate bath at the above temperature is satisfactory for small articles. The time of heating will vary from 30 sec. to several minutes, depending on the metal thickness. In all cases, however, a fast method of heating should be used to prevent grain growth.

Lubrication of the blank during spinning is important because aluminum is quite easily marred in this process. Beeswax, tallow, and petroleum jelly are suitable for small pieces. When spinning large diameter blanks which require heavy tool pressure, the lubricants mentioned are not satisfactory because the forming tool cuts through and mars the metal. In such cases, ordinary yellow laundry soap will prove satisfactory to lessen friction and avoid scoring the metal.

There is no essential difference in the process used for making spun articles of aluminum and aluminum alloys from that used for copper and brass, except that higher speeds are employed. The peripheral speed employed in spinning aluminum depends not only on the blank diameter and the thickness but also upon the contour of the shell to be formed. It is usual practice to increase the speed of rotation as the diameter and thickness decrease. Lathes should have at least three speeds, such as approximately 1,200, 700, and 250 rpm. The lower speeds are used for large items and thick sheet. Table I gives the speeds for spinning blanks of various sizes.

The speed at which the lathe is operated may also be governed by the diameter of the chuck—the smaller the chuck, the greater the rotary speed. Speeds given in Table II have proved satisfactory, although each operator will have his preferences.

If the shell is of a design permitting direct withdrawal of the chuck, a one-piece chuck is employed; but if the shell partially encloses the chuck during spinning, sectional or off-center chucks are used. Sectional chucks are constructed so that by removing a key section the other pieces can be removed one at a time. These sections must fit perfectly at the joints, for the slightest irregularity will be impressed in the spinning.

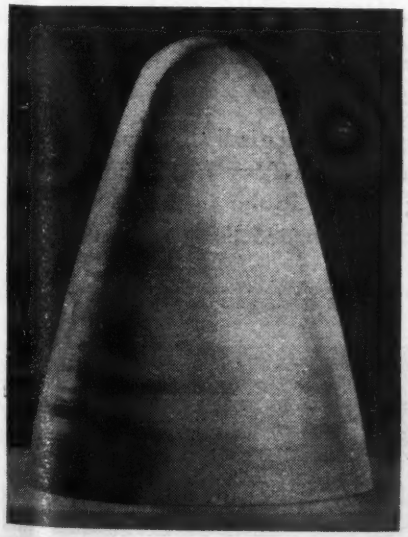
The off-center chuck permits spinning over a solid form which comes in contact with the work only at the point of spinning and is small enough to pass through the

(*Turn to page* 253)

Spinning large shell by semi-mechanical method, using two screws for feeding tool against work.

Table II—Speeds for Spinning Aluminum Shells

Mean Dia. of Shell, In.	RPM.
10–14	1,200–1,000
14–20	800– 650
20–30	550– 475
30–40	375– 325
40–50	300– 250
50–70	210– 200
70–90	175– 150



Tank end was first drawn, then spun on lathe.

Sectional chuck used if metal envelops it.

Off-center chuck used with small opening.

ONE OF America's first pilot training organizations to fly a million hours, Southwest Airways has trained pilots from some 29 different countries at its 4 great flying fields in Arizona.

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FOR THE AVIATION INDUSTRY

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

NEW SYSTEM SIMPLIFIES ENGINE CLEANING

By **T. J. KEARNEY,** *Technical Assistant to Vice-President, Dextrex Corp.*

How former dirty and time-consuming job has now been streamlined, resulting in new efficiency in the aircraft overhaul plant.

CONTINUOUS EFFICIENT MAINTENANCE of the AAF is as precisely essential as was both the initial organization and construction phases—for once built, a military striking force must ever be kept in top shape for action.

Further, every good maintenance man quickly realizes that the system of "upkeep" is like the proverbial chain—only as strong as its weakest link. One of the "links" is the specific job of cleaning aircraft engines prior to complete overhaul, and it is an operation which has presented many new problems.

Necessity for complete yet rapid soil removal with a minimum of hand work is the major problem. This article will outline some of the important advances which, based on experience, are today producing most noteworthy results.

Disassembly of aircraft engines is handled in the usual manner. The entire engine is broken down into its component parts so that each may be cleaned and inspected prior to reassembly. Parts are placed directly on 42-in.sq. trays in subassembly groups. Four of these trays accommodate the major parts of a 9-cyl. radial engine, and a dolly should hold the four. These trays, full of work, are then placed in a vapor-slush type solvent degreaser.

The solvent used is commercial stabilized trichlorethylene. For the cleaning of this work only the most highly stabilized type of degreasing solvent available should be used. Required physical properties of the solvent are listed in Table I.

In degreasing, all parts of the engine are cleaned except pistons. The crankcase sections should be cleaned individually, this being necessary in order to drain completely these parts and to obtain total degreasing. Parts are left in the vapors of the solvent, then washed with a hand spray of clean solvent distillate generated by the degreasing equipment (see Figs. 1 and 2).

Use of the solvent degreasing cycle assures the removal of all oils and greases from the engine parts and allows no contamination of the work. All cleaning is accomplished by pure solvent vapors and clean distilled solvent. Work leaves the degreaser oil free, dry, and at a temperature of 188 deg. F.

The large parts which were cleaned individually should be replaced on work trays. The loaded dolly is then moved, by an overhead hoist, to the soaking tanks. These soak tanks are thermostatically controlled at 140 deg. F. Agitation is required for effective results, and a cleaning cycle of 30 min. has proved satisfactory. Mechanical agitation is recommended, since air agitation may cause excessive loss of solution strength. The soaking tanks are large enough to hold four fully loaded dollies at one time (see Fig. 3).

Table I—Required Physical Properties Of the Solvent

Specific gravity	1.465 to 1.475 @ 15°/4° C.
Moisture	Water content should be such that solvent may be cooled to—10° C. and allowed to come to room temperature without cloud formation.
Non-volatile matter	Not to exceed 0.03% by weight.
Alkalinity	Initial: .048 to .077% by weight, calculated as NaOH.
Distillation	Middle 50%. Upon distillation not less than 60% of initial should show the following: Initial point of Min. 84.4° C.; 95% or better should distill between 84.4 C.–90° C.

Fig. 1. Vapor slush degreaser for cleaning aircraft parts.

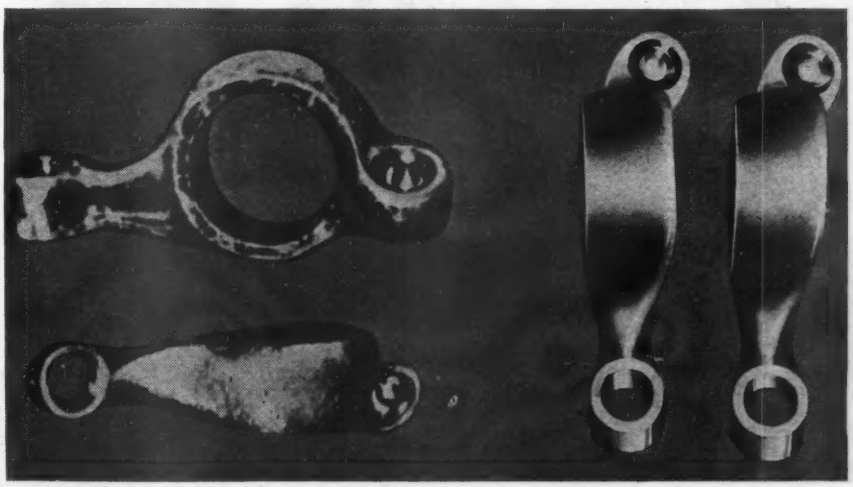


Fig. 2. Aircraft parts before and after cleaning.

Fig. 3. Dolly of aircraft parts being lowered by electric hoist into soak tank.

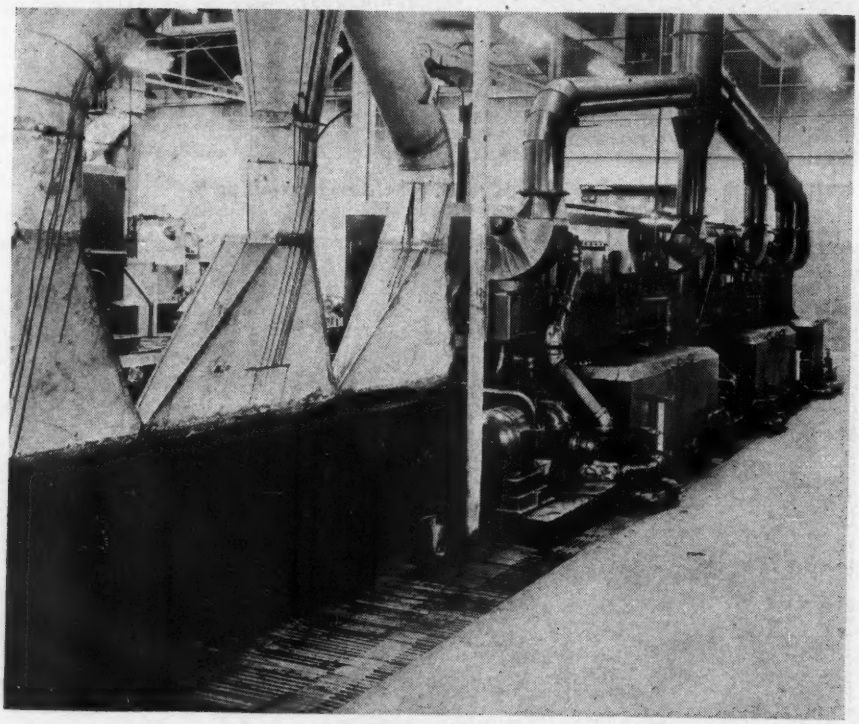


Fig. 4. Position of Dextrex washer (right) with respect to soak tank. (U.S.N. photo.)

The cleaning solution used is of the cresol type and should be employed with adequate local ventilation on each tank (see Fig. 4). This cresol base cleaning compound must have the general properties outlined in Table II.

After the work has been allowed to

Table II—Properties of Cresol-Base Cleaning Compound

(1 part compound and 4 parts distilled water)

Oil removing ability	Cleaning solution should be able to remove SAE #50 oil from anodized aluminum sheets in 15 min.
Paint stripping ability	Cleaning solution should be able to strip a panel with a zinc chromate primer and a black enamel glyceryl phthalate, final coat baked for 2 hr. at 360° F. without attack or oxidation of base metal.
Rinsing	Cleaned surfaces should show no sticky or iridescent film after reasonable rinsing in water.
Acidity	pH @ 20° C. shall be between 7.5 and 7.7.
Corrosiveness	Solution should not show any visible corrosive attack on polished steel, copper, anodized aluminum, or magnesium alloy, and not more than slight discoloration on polished aluminum alloys or cadmium plated steel after immersion.

remain in the soak tanks, the trays are removed while still hot and are sent through the conveyorized washer. The overhead hoist raises the dolly out of the soak tank only long enough to slide the trays on to the gravity-roll loading station of the washing machine.

Next, the work is carried through the washer on a slat conveyor (see Fig. 5). This type of conveyor presents a minimum of "shading" to the work being cleaned and allows for maximum drainage, thus eliminating carry-over of solution from one stage to another. The first stage consists of a high pressure spray (700 gpm. at a 50 ft. head) of a cresol type cleaner for 2 min.

From here the work moves to an inspection opening to permit crankcases and other similar pieces to be tilted by hand for drainage in order to eliminate excessive dragout.

Trays move from inspection into an emulsion cleaner spray. On emergence from this compartment into a second ventilated inspection position, the work is tilted to drain shallow cavities.

Passing through the final stage of the conveyorized washer, the parts are subjected to a thorough, hot-water, high-pressure spray rinse and are discharged onto the unloading platform. At this point, water can be blown off with compressed air. Since the parts are warm, they will dry readily and inspection for cleanliness can be made (see Figs. 6 and 7).

Any parts requiring hand operation for further cleaning can be segregated and routed to the hand cleaning booths; otherwise, the trays can be routed directly to inspection (see Fig. 8).

The washer is provided with curtains at the entrance and exit ends as well as baffles at the spray chamber in order to separate entirely the operations and solutions of the several stages.

Special features are incorporated in the wash stage to combat the foaming tendencies of the cresol type cleaning compound, and the charging boxes are provided with hinged water tight covers. Solid jet-type nozzles are used to keep the foaming and atomization of the cleaning compound to a minimum.

The washer is provided with start-stop controls at the load and unload stations as well as safety stop stations at each inspection and draining opening.

Pistons are cleaned by placing them in pressure cleaning tanks and by blasting with bird seed. Another successful method for cleaning pistons is solvent vapor degreasing to remove all traces of oil and grease, followed by high pressure blasting with wheat or plastic particles. The wheat is chopped, dehydrated wheat giving a particle size about twice that of

Table III—Properties of Specified Emulsion

Color	Amber
Boiling point	208° F.
Specific gravity	.840 @ 25° C.
pH (electrometric)	11.5
Flash point	150° F. open cup
Freezing point	10° F.
Weight per gallon	7.0 #/Gal.

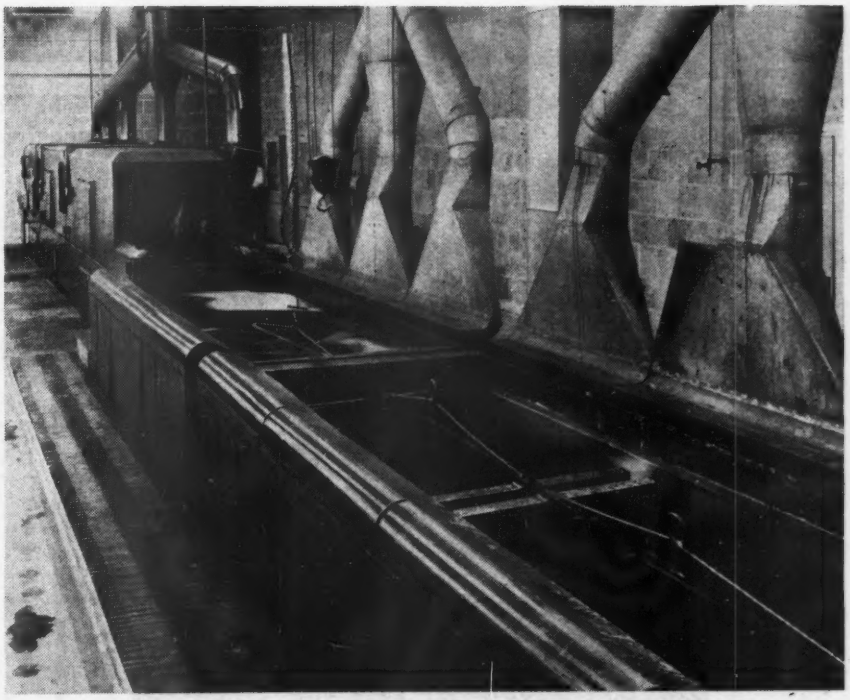


Fig. 5. Soak tanks and Dextrex washer from operating side. (U.S.N. photo.)

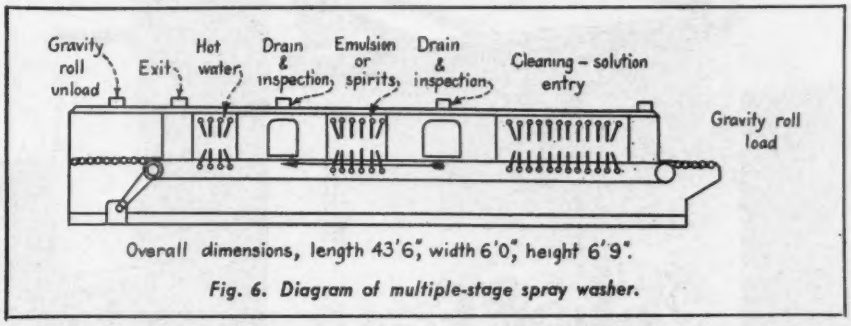


Fig. 6. Diagram of multiple-stage spray washer.

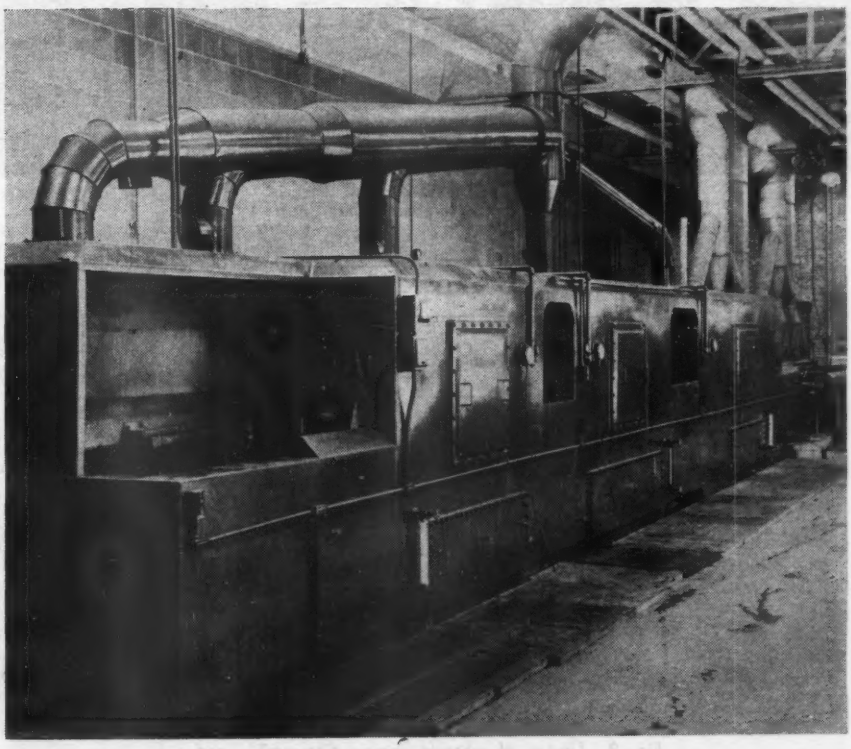


Fig. 7. Washer used on aircraft parts. (U.S.N. photo.)

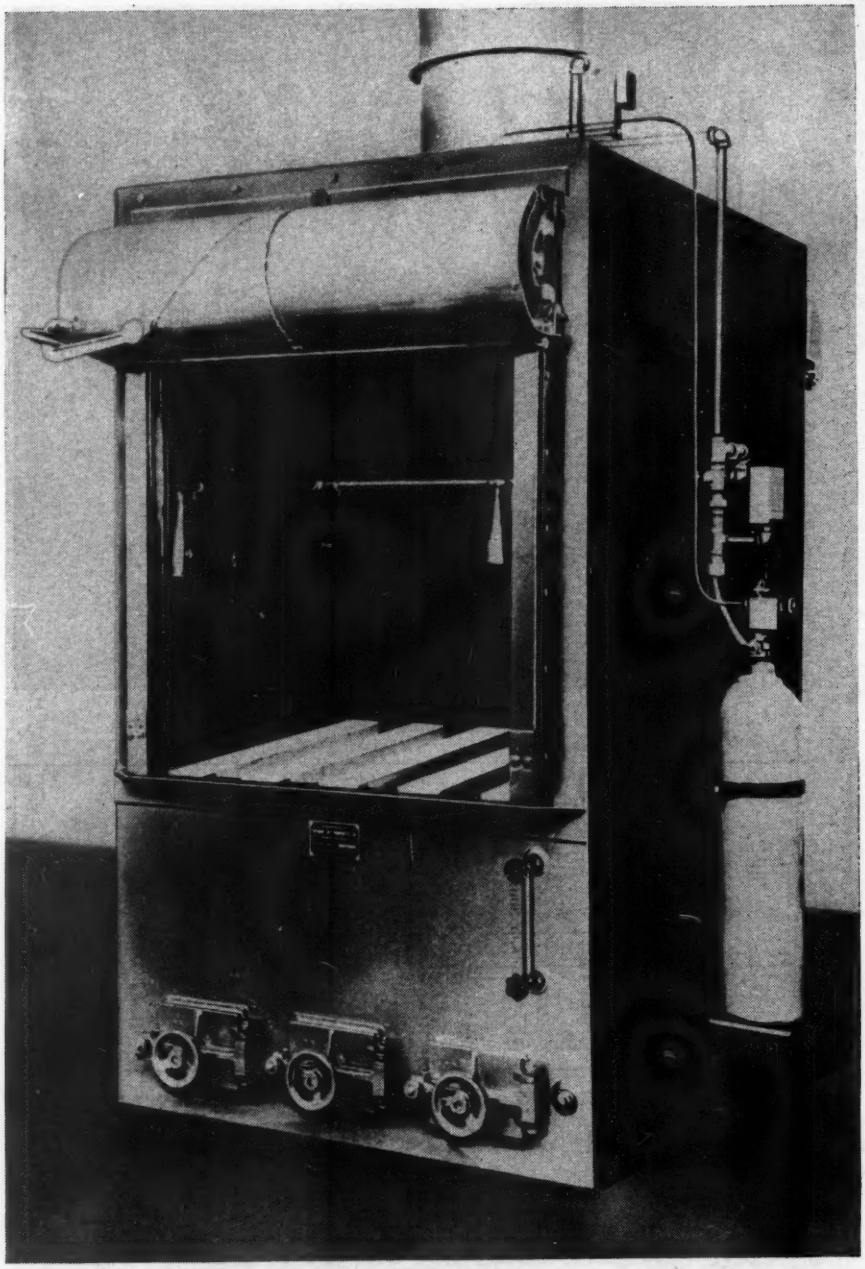


Fig. 8. Spray booth for cleaning small parts by hand.

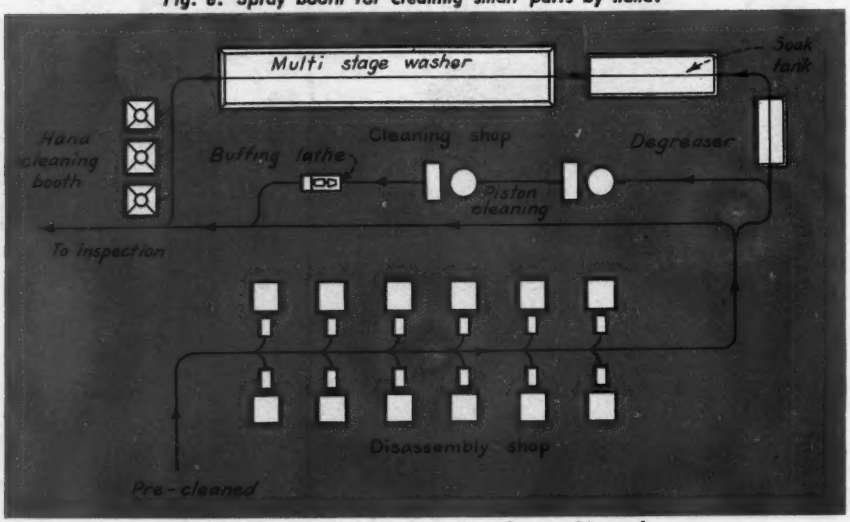


Fig. 9. Layout of aircraft engine disassembly and cleaning shop, showing sequence of operations.

ordinary blasting sand. These materials, as effective and long-lasting as sand, do not damage the smoothly finished surfaces of the pistons.

Thereafter, the pistons are placed on the continuous washer at inspection opening preceding the soap spray. After they have received an emulsion spray and hot water rinse, they are further cleaned in hand-cleaning booths. The emulsion material mentioned has properties outlined in Table III.

If any carbon remains on the parts—it's often found on the upper end of the link rods—this can be removed by buffing, followed by a final cleaning operation in one of the hand booths to remove any traces of buffing compound.

Petroleum spirits cleaning: Referred to in connection with hand cleaning and shown in Fig. 8, this phase of metal cleaning commonly uses a petroleum fraction with a closed cup flash point ranging from 100 to 150 deg. F. These solvents, sold under various trade-names by the major distributors of petroleum products, fill a definite requirement in the metal cleaning field. They can be used when a high degree of cleanliness is not essential and if the only contamination consists of oil or grease.

Many delicate parts of assemblies which could not be allowed to come in contact with water and upon which a light oil film is desired can be cleaned only by this method, which invariably leaves the surface slightly oily.

Petroleum solvents also answer the essential need to fill in cleaning parts which have been previously painted, also where other cleaning methods would have adverse effects upon the surfaces. These solvents are used without heat in one or two stages of immersion, often, too, in spray washing equipment with as many as three consecutive spray stages. Frequent replacement of solvent is necessary because the contamination of 2 percent by volume usually results in unsatisfactory cleaning results.

Contaminated solvent can be reclaimed by distillation in properly designed stills. These solvents are volatile and definitely constitute a fire hazard. They should be used only in equipment properly designed for their application.

Care must be taken in designing this equipment to eliminate possible sources of sparks, and adequate fire prevention equipment, such as a carbon dioxide system, should be incorporated.

With equipment outlined above, much labor and time is conserved, excellent and uniform results can be obtained, and only 1 percent of the dirt or carbon requires hand labor for removal. A 9-cyl. air cooled radial engine can be cleaned in less than 1½ hr. A similar cycle is adaptable for the cleaning liquid-cooled aircraft engines with very few changes required.

Because the large airlines are concentrating major overhaul at one location, and in many cases are also performing overhaul work for the armed forces, a complete cleaning arrangement (as outlined in Fig. 9) may be desirable.

Operation and Servicing Of Zero-Lash Valve Lifter

THIS LIFTER consists of outer body *A*, having a straight, machined hole to receive hydraulic unit which comprises cylinder *B*, plunger *C*, ball check valve *D*, and plunger spring *K*. Oil under pressure from lubricating system is supplied through hole *H* to supply chamber *J*.

When lifter face is on cam circle and valve is seated, spring *K* lifts plunger *C* so that all clearance in valve train is taken up. As *C* moves outward, increasing volume of oil in *L* ball check, *D* moves off its seat and oil from *J* flows in and fills *L*.

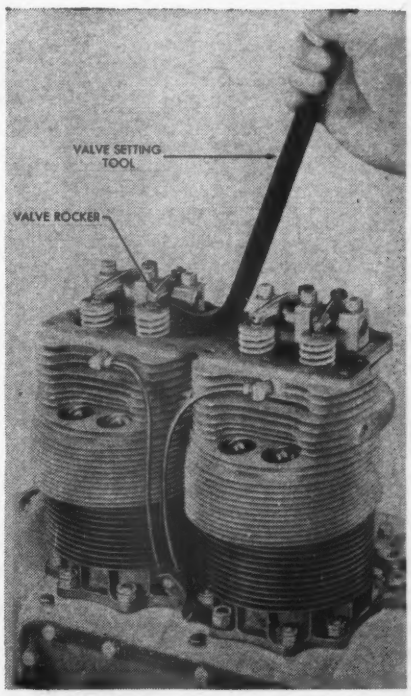
While camshaft rotates, cam pushes lifter body outward, tending to decrease volume of *L* and seating valve *D*. Further rotation of camshaft moves lifter body *A* outward and oil confined in *L* acts as a solid member of valve train, valve being lifted on a column of oil, which carries valve as long as it is off its seat. During this period a slight predetermined leakage takes place between plunger and cylinder to compensate for any expansion or contraction in valve train.

Immediately after valve closes, oil flows into *L* through *J* to provide correct column length for next cycle.

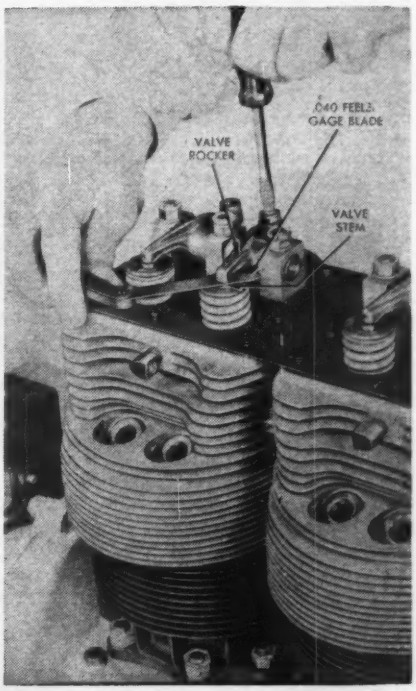
It is impossible for this lifter to hold valve open when it should be closed, since, when *A* is on surface of cam and valve is closed, only pressure tending to open valve is that of light plunger spring *J*.

Proper clearance between valve rocker and stem is .040 in. with piston in firing position and all oil forced out of hydraulic lifter by pressing back on valve rocker with valve setting tool until no further clearance is obtained. If lifter fails to function, clearance between valve stem and valve rocker will be approximately .100 in., with danger of considerable damage being done to parts.

When adjusting screw on end of rocker arm, push rod should be held compressed so that required .040-in. measurement is made without there being any tendency to increase distance by springing rocker arm.

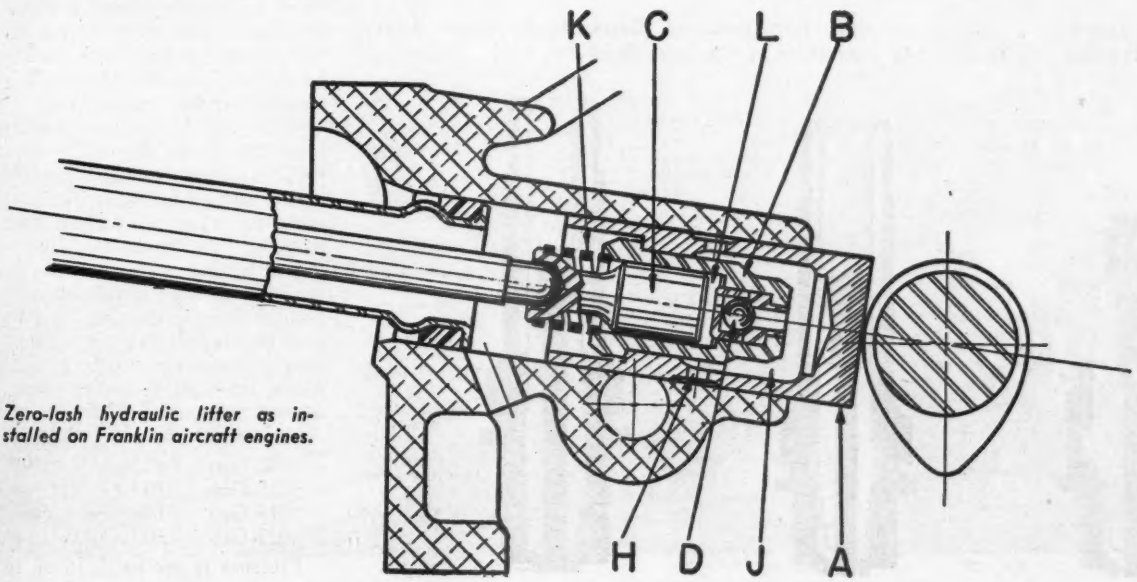


Method of forcing oil from lifter.



Making rocker adjustment.

(Aircooled Motors Photo)



Zero-lash hydraulic lifter as installed on Franklin aircraft engines.

STEPS IN SERVICING CHAMPION SPARKPLUGS

A graphic picture account of the methods recommended by the manufacturer for inspecting, cleaning and adjusting sparkplugs, including final testing steps prior to reinstallation.

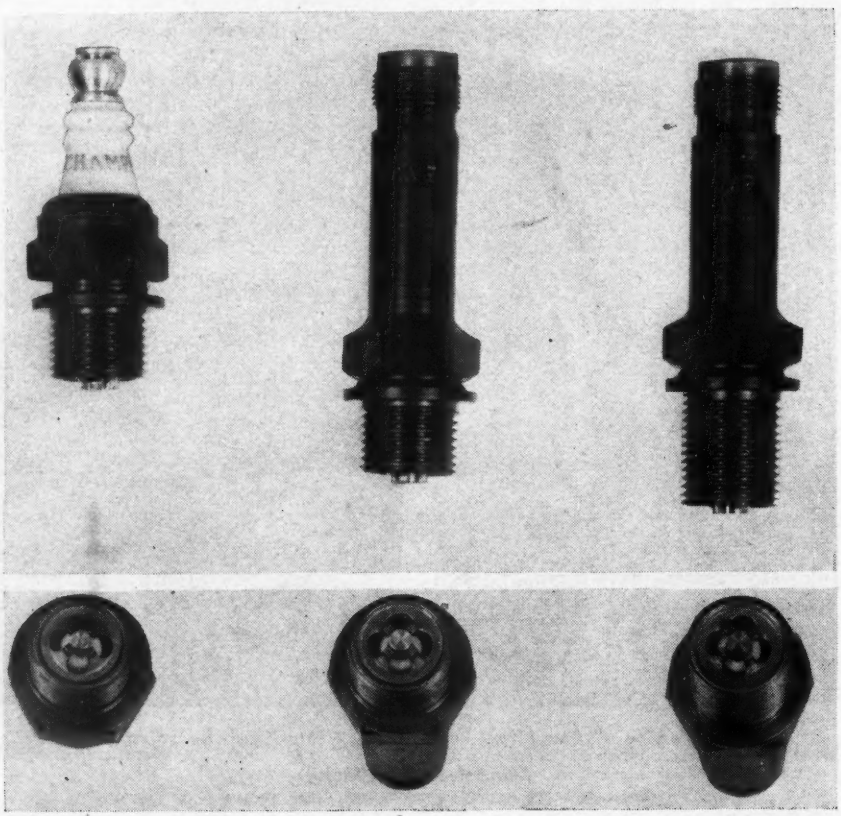
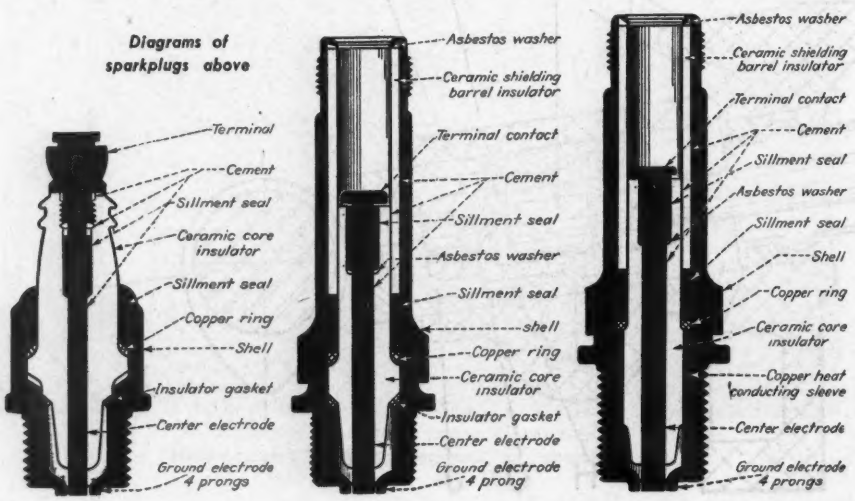


Fig. 1. Three types of aviation sparkplugs. Left: Unshielded. Center: Shielded, short thread. Right: Shielded, long thread. (All illustrations by Champion Spark Plug Co.)



TWO STEPS are primary in the servicing of sparkplugs—the cleaning and adjustment of the points. However, before launching any considerable amount of servicing, a sparkplug should be carefully inspected to locate, if possible, any damage which may have occurred either during use or handling, thus disabling the plug. For many sparkplugs which have been carefully serviced and adjusted before such inspection have been found unsatisfactory when tested later.

It is stated that cleaning of Champion electrodes is usually performed by soaking in Klenzol, care being taken to make sure that no liquid enters the well at the upper end of the plug. The lower end is then blown out and sandblasted, being rocked with a rotary motion over the blast. This step should not be prolonged to over 3 sec. or the electrodes may be damaged. The sand is then blown out and the ceramic shielding on the inside of the barrel is cleaned with the tool shown in Fig. 11a. alcohol should be used—never a chemical solvent, since the latter has a tendency to remain at the bottom of the cavity and cause trouble later. If alcohol alone will not clean the ceramic lining, a little Bon Ami may be used with it.

In employing the electrode-adjusting machine (Figs. 13 and 13a), the operator should carefully avoid damage to the center electrode caused by pressing against outer point when feeler gage is between the parts. The center electrode is made with a tungsten point which will not stand heavy side pressure, though it is entirely suitable for its regular work.

When completely cleaned, adjusted, and inspected, plugs should be stored carefully to prevent damage, preferably with plastic caps (shown in Fig. 19). Plugs returned to service should have a mica base lubricant in the threads.

In tightening sparkplugs in cylinder heads, a torque wrench should be used, both to preserve the plugs and also to prevent damage to head bushings. Makers advise following torque: For 18-mm. plugs, max. 40 ft-lb. or 480 in.-lb.; for 14-mm. plugs, max. 30 ft.-lb. or 360 in.-lb.

Gaps should be set as follows:

.012 Gap	.011 Go	.014 Nogo
.015 Gap	.014 Go	.016 Nogo
.019 Gap	.018 Go	.020 Nogo
.022 Gap	.020 Go	.024 Nogo

Pressure is applied 1/16 in. from ends.

Fig. 2. Inspect points for burned prongs.

Fig. 3. A plug with end damaged (as above) should be rejected.

Fig. 4. Soak plugs in approved solvent, keeping ends above liquid.

Fig. 5. Blow off excess cleaning fluid, directing air downward.

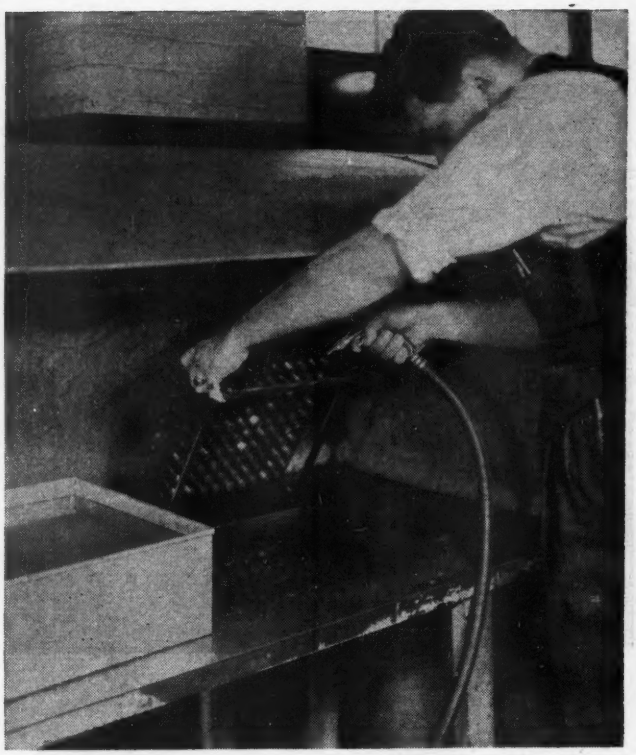


Fig. 6. Next tilt plugs and dry lower ends with air pressure.

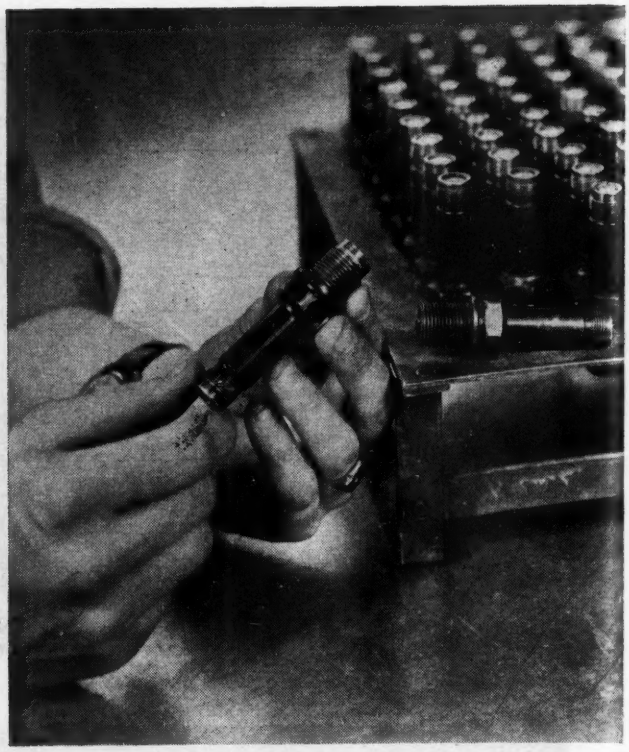


Fig. 7. Inspect threads on both ends watching for bruises

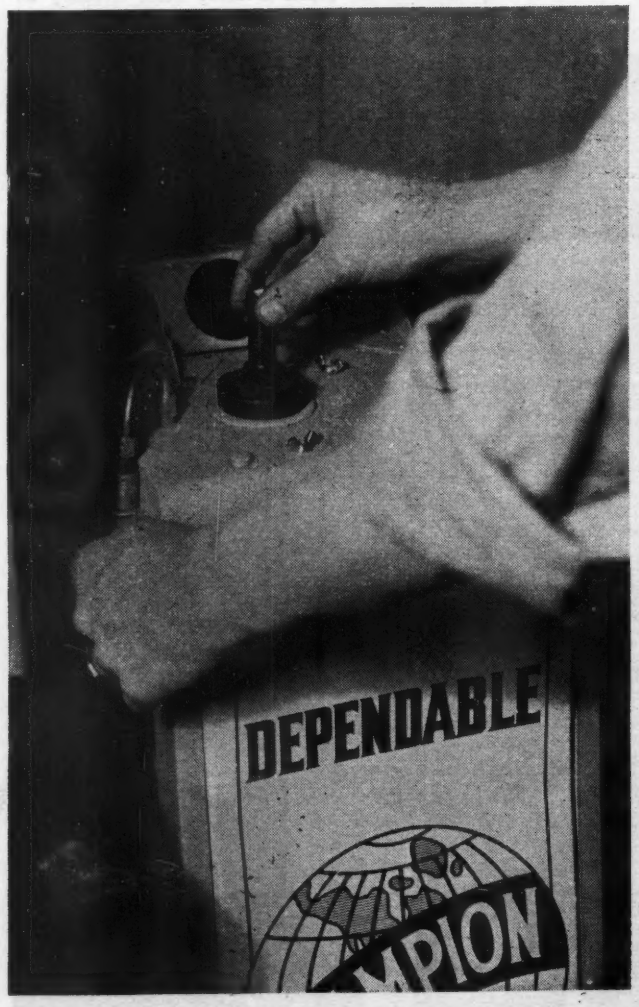


Fig. 9. Sandblast for 3 sec., revolving plug during operation.

Fig. 8. Check threads with gage and remove bruises with standard die.

Fig. 10. Blow sand out of cavity in plug.

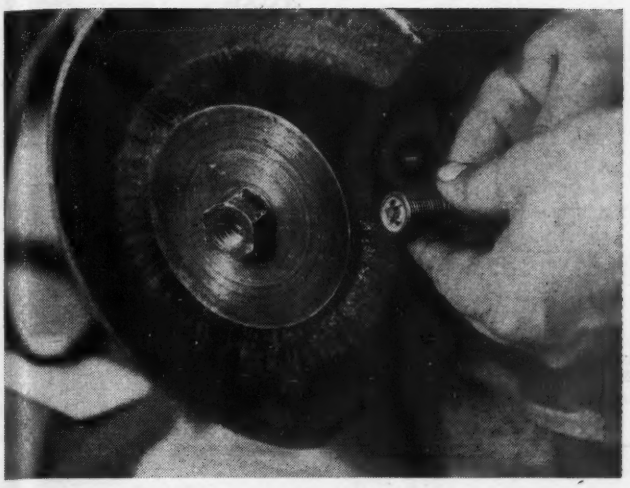


Fig. 11. Brush threads on .007-wire wheel, keeping wire out of plug end opening.

Fig. 11a. This tool, used with alcohol, cleans internal ceramic shielding.

Fig. 12. Chief Inspector B. L. Christman examines a sparkplug after cleaning. Instrument is twin-eyepiece microscope, fitted with spotlight.

Fig. 13. Machine designed and built by Champion for adjusting sparkplug gap. Go-Nogo gage measures .011 and .014 in.

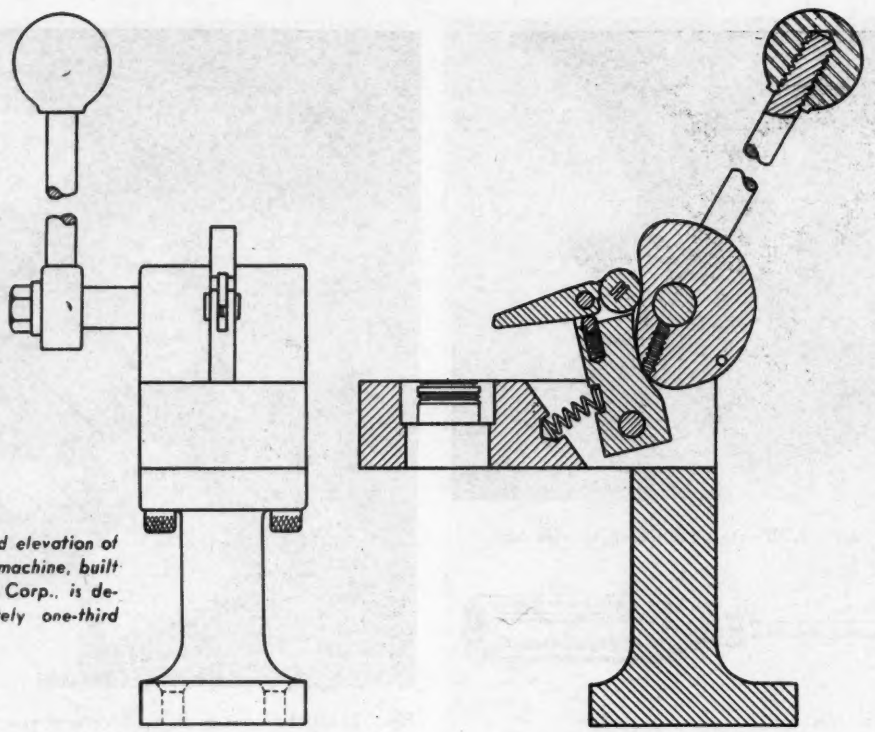
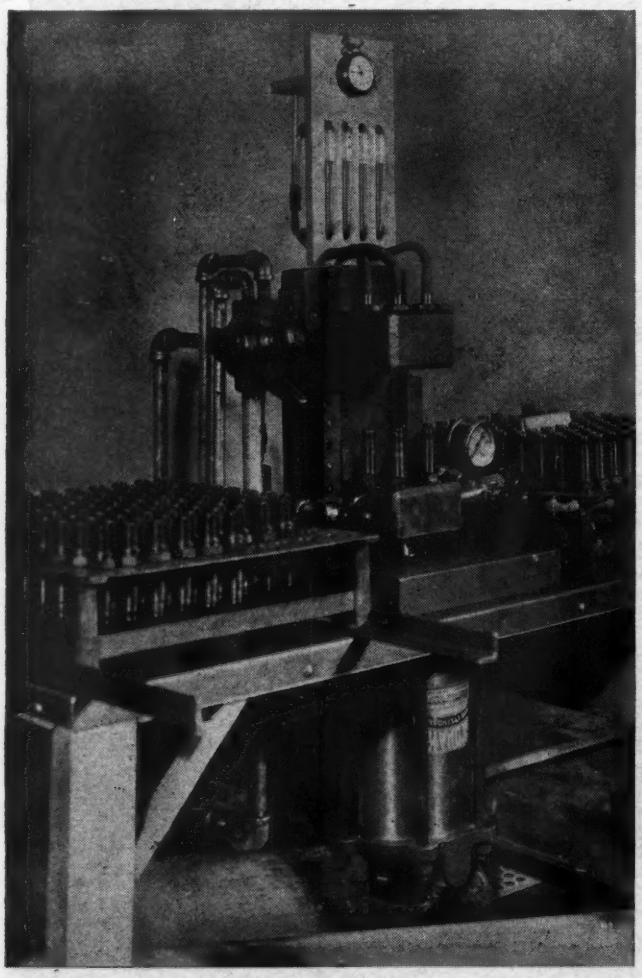
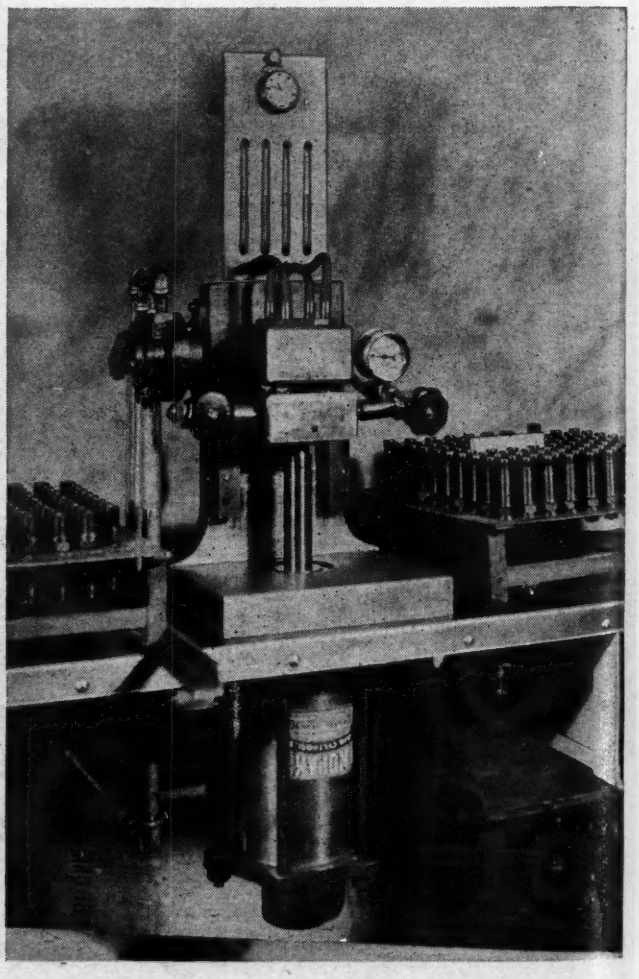
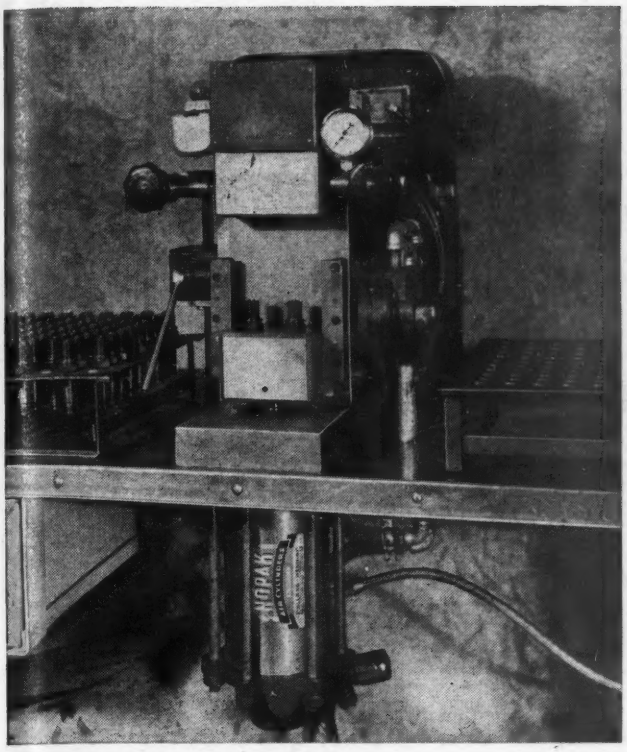


Fig. 13a. Section and end elevation of sparkplug-gap adjusting machine, built by Champion Sparkplug Corp., is depicted here approximately one-third size.





Figs. 14 and 15. This machine tests plugs for leakage under 800 psi. air pressure for 15 sec., leakage being restricted to .5 cc. and indicated in manometer tubes at top of board. Left: Machine open. Right: Closed with plugs under pressure. Note pressure gage readings at right of machine, also varying manometer levels. Few plugs are absolutely tight.



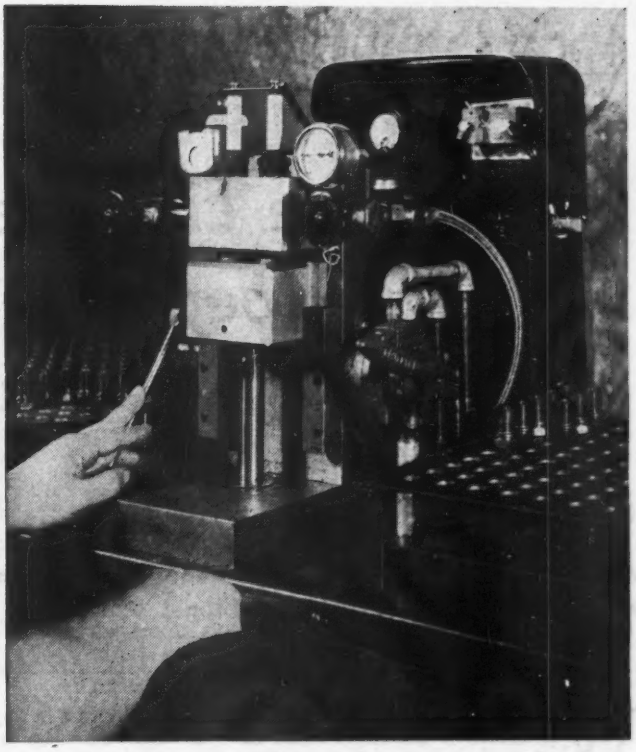


Fig. 16 and 17. Electrical test. Machine (open at left) shows plugs in position. When closed (right) gage indicates air pressure, while heavy spark—9,000 v.—jumps gap at upper right. Any short circuit in plug kills spark.

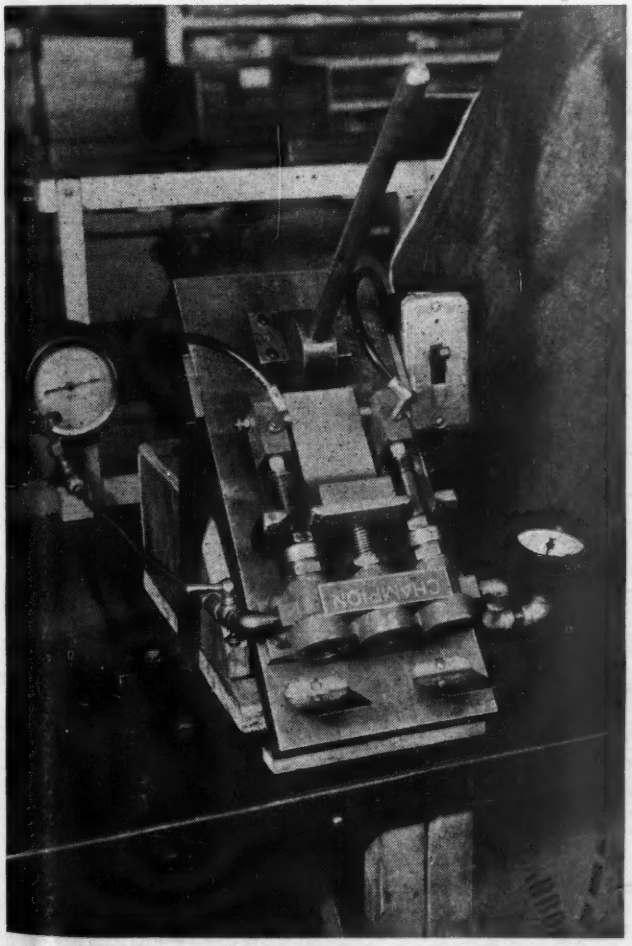


Fig. 18. Plugs are electrically tested in this machine. Sparks shine through glass bottoms of holders, and light is reflected from metal mirrors at bottom of board.

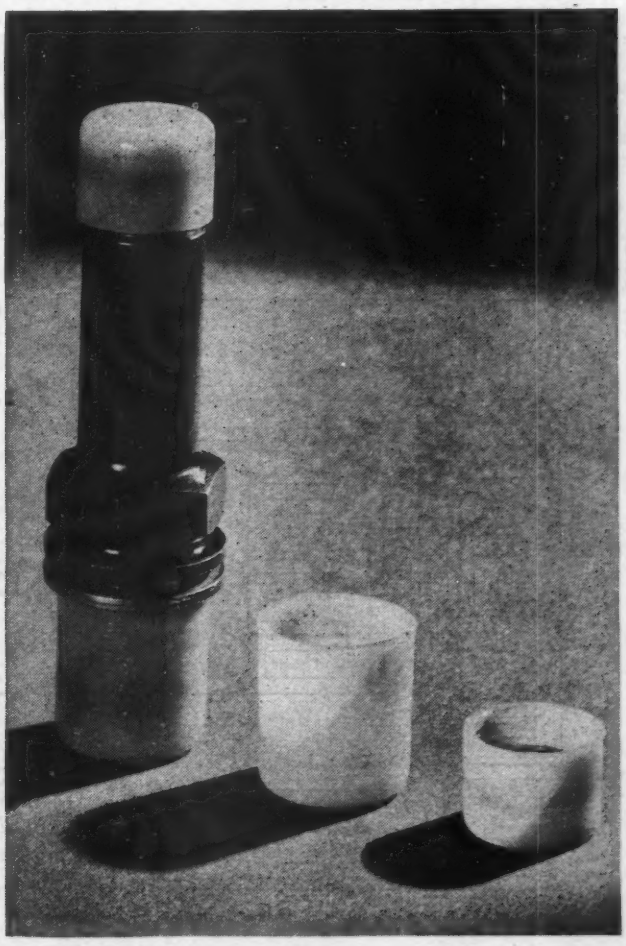
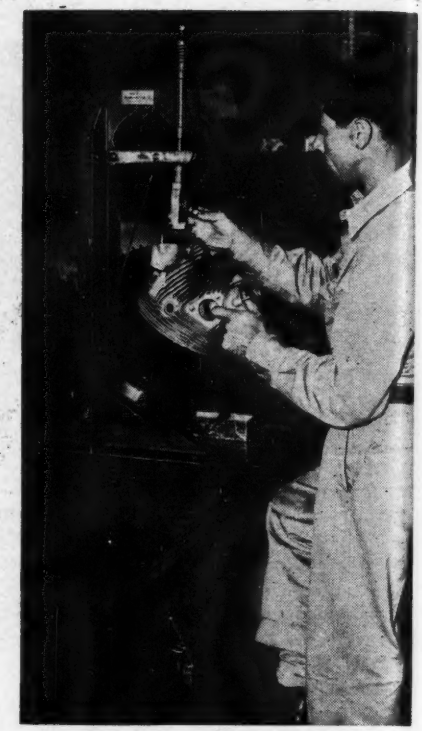


Fig. 19. Sparkplug, completely reconditioned and painted, is fitted with washer and plastic caps to protect ends from dirt and damage. Paint is quick-drying type.

Progressive Line Methods Expedite Engine Overhaul

By **J. R. HORTON,** *Vice-President, Embry-Riddle Co.*

Adoption of new time-saving methods in engine overhaul enables depot to increase output many times.



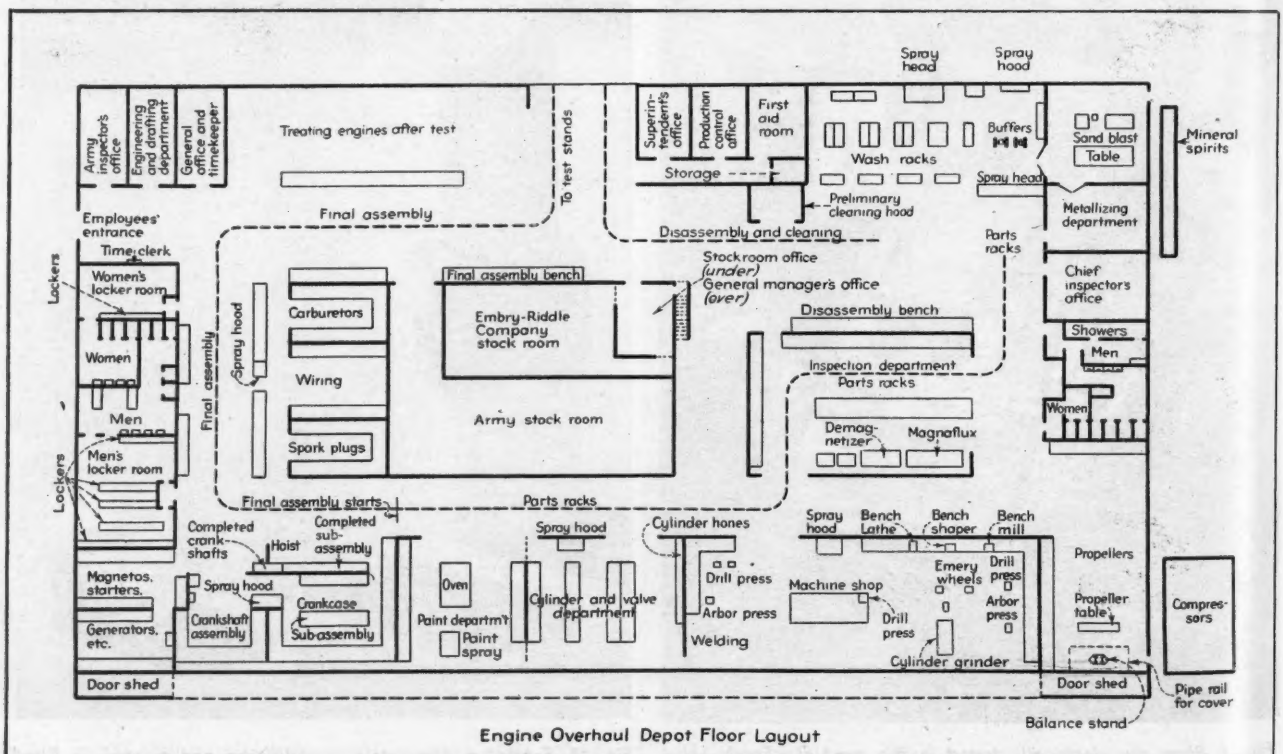
Valve spring compressor is used both in assembly and disassembly, being operated by treadle. This allows use of both hands and eliminates risk of injury.

WORK ON the engine overhaul department of the aircraft and engine div. of the Embry-Riddle Co. was started May 1, 1942, from grass roots. The period from May 1 to Aug. 15, 1942, was spent manufacturing tools, fixtures, and other equipment, and in training personnel for the complete major overhaul of engines, propellers, and accessories.

On Sept. 11, 1942, after a month spent in training and setting up shop, the first engine was overhauled, test run, and accepted by the Army. From that time to date the shop has completed major overhauls of more than 3,000 trainer engines, plus many additional accessories.

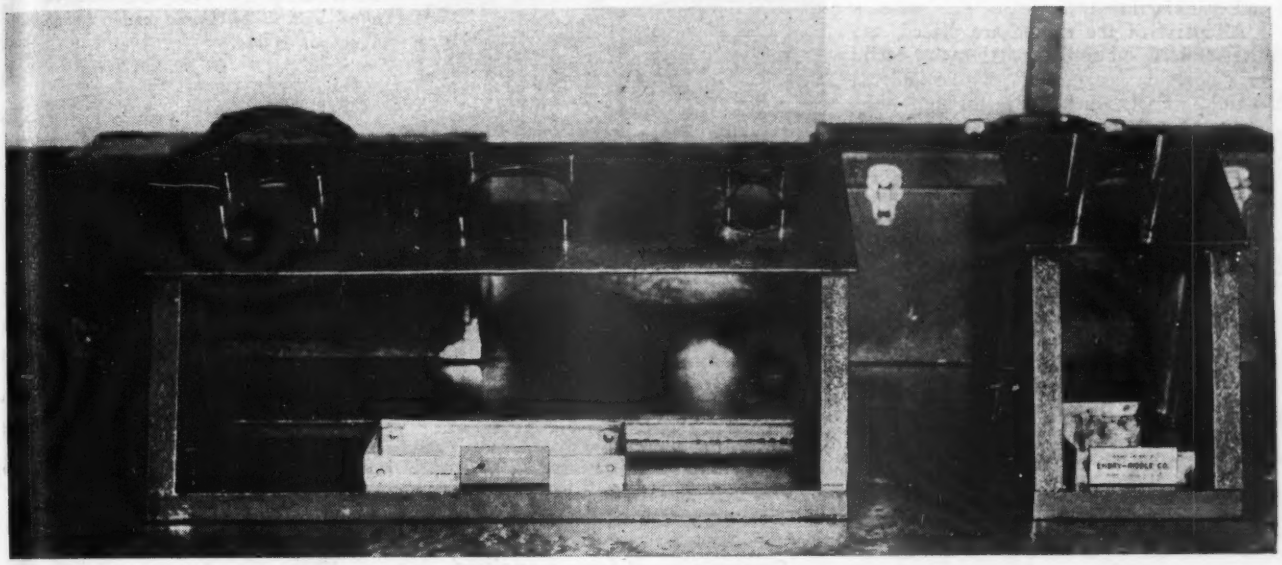
Engine overhaul is carried on in approximately 30,000 sq.ft. of floor surface. As tools and fixtures were practically unobtainable, or at least not obtainable for many months, these were designed and built by us. This enabled us to improve upon existing fixtures and to devise new ones, resulting in accelerated production and decreased employee fatigue.

When received for overhaul, engines are first uncrated and immediately placed in a pre-cleaning booth in which all preservative compounds, grit, and grime are removed. Then engines are mounted on



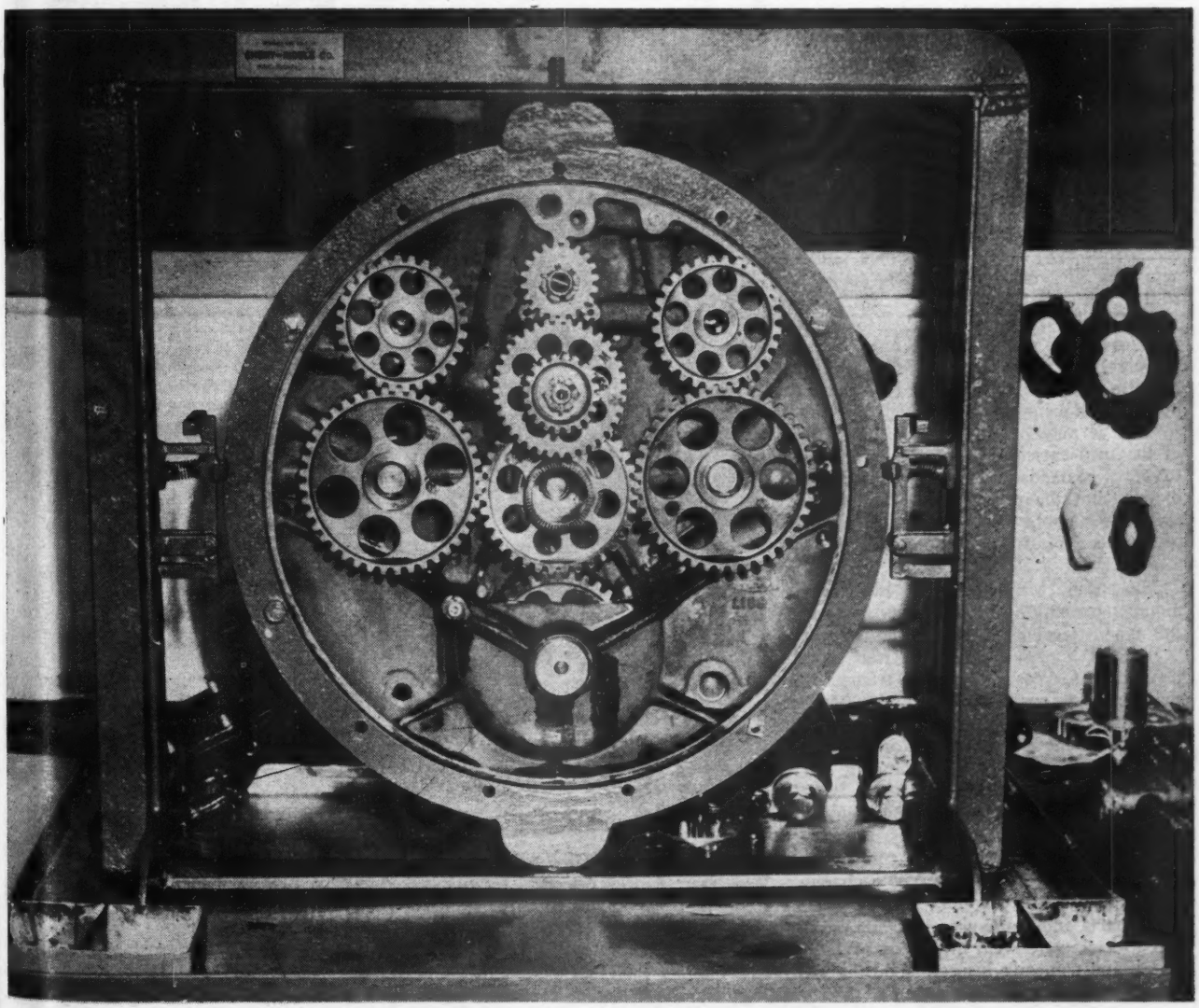
Engine Overhaul Depot Floor Layout

Plan of shops and offices of Embry-Riddle overhaul depot, showing flow of parts during engine disassembly and repair.



Above: These oil pump and accessory drive fixtures are so designed that dowels hold the units securely, permitting them to be placed in position or removed without use of any other fastening.

Below: Rear case fixture used for disassembly and assembly. It will pivot and automatically lock with either front or back to mechanic, greatly increasing accessibility.



disassembly stand, of our design. Engines next travel through progressive disassembly, which is expedited by special fixtures and tools, also of our own design and manufacture.

All parts of the engine are placed, as disassembled, on rolling parts racks, each rack holding parts for one complete engine. Parts then pass through the cleaning department, each being thoroughly cleaned, polished, buffed, or sand-blasted, as may be required.

Next, parts pass into the inspection department, where each is either visually or magnetically inspected. Here, defective parts are rejected and new parts are requisitioned as necessary. Parts requiring rework are sent to the machine shop and rework department. After the necessary work has been completed, the parts are returned to the rolling rack. Racks then are moved through the various sub-assembly departments, first entering the cylinder department where cylinders are inspected, honed, or reground, as necessary. Valve seats are refaced or replaced and, after repainting or metalizing, each cylinder unit is assembled as far as is possible at this stage. During this same period, the oil pump, carburetor, gear case, magnetos, starter, and other components, are similarly reassembled and tested.

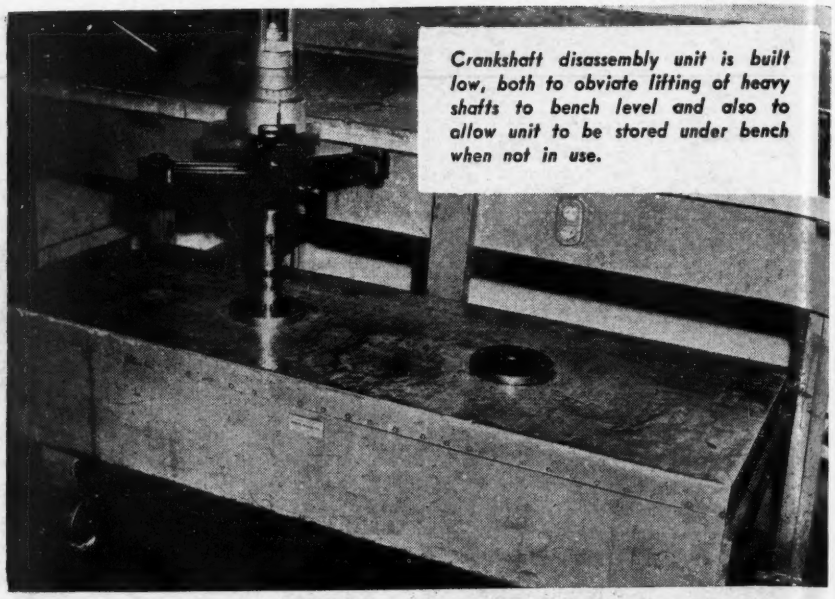
After inspection and refinishing, one section of the crankcase is mounted horizontally on the universal bedplate of a rolling assembly stand. The crankshaft assembly is then lowered, by means of a chain hoist, into its proper position in the crank case. Next, the other half of the crank case is added and the assembly continues along a progressive line to receive the cylinders, carburetor, starter, magnetos, and other accessories such as the wiring harness and spark plugs. The timing is checked and the engine is then routed to the test stands.

The engine is lifted directly from the final assembly stand and mounted on a universal bed plate on one side of our "shuttle jeep." This jeep has a chain hoist which lifts the engine to be tested so that it may be mounted on one side of the jeep carrier. Then the jeep goes to the test stands where it uses its hoist to dismount the engine previously tested and then mounts it on the opposite side of the carrier from the engine to be tested.

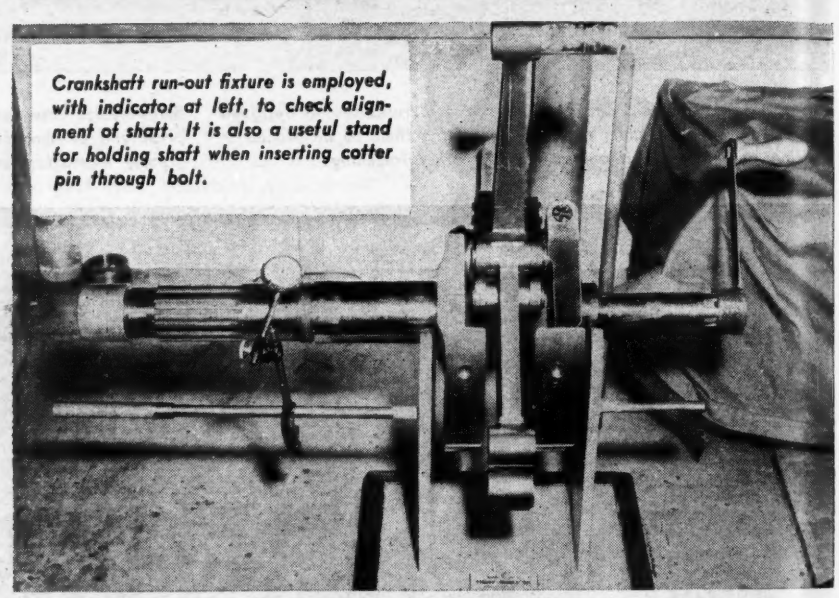
The engine for test is then lifted and mounted directly on the test stand. Here, the engine receives a fully calibrated test of several hours' duration. After completion of the tests, the jeep transports the engines to final inspection and treating department, where they are thoroughly checked, cleaned, and treated for storage.

Next, engines enter the shipping department, where they are encased in Pliofilm protective envelopes, from which all excess air and accompanying moisture is exhausted by means of a vacuum line. Final operation is placement of each engine in a box with shipping instructions.

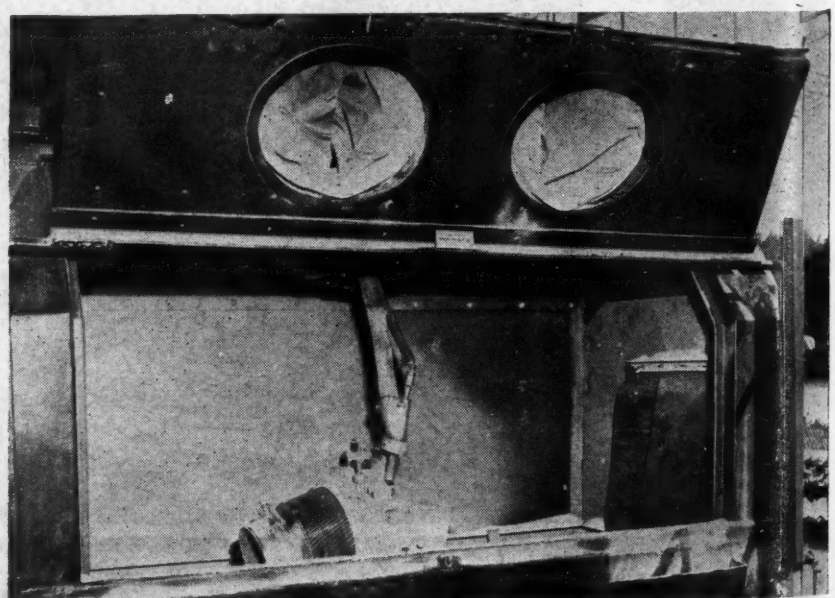
All parts and work are, naturally, subject to extremely rigid inspection by both Army and company inspectors during all phases of the overhaul operation.



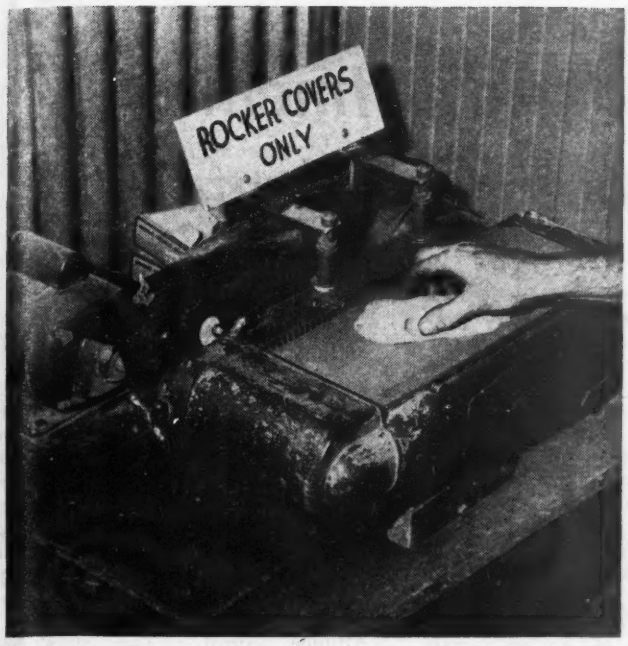
Crankshaft disassembly unit is built low, both to obviate lifting of heavy shafts to bench level and also to allow unit to be stored under bench when not in use.



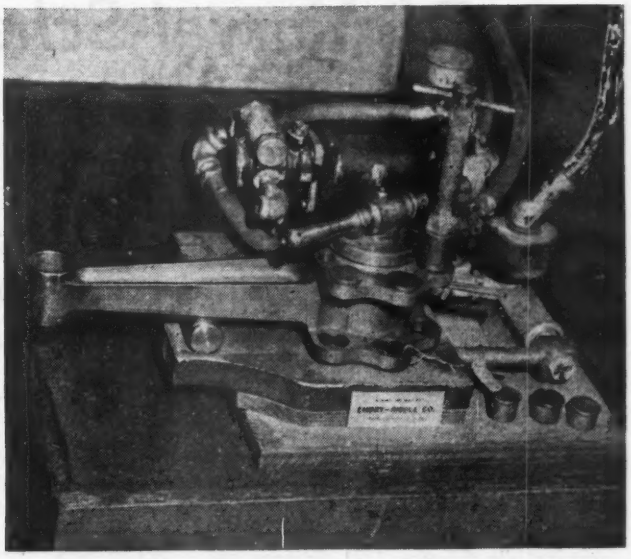
Crankshaft run-out fixture is employed, with indicator at left, to check alignment of shaft. It is also a useful stand for holding shaft when inserting cotter pin through bolt.



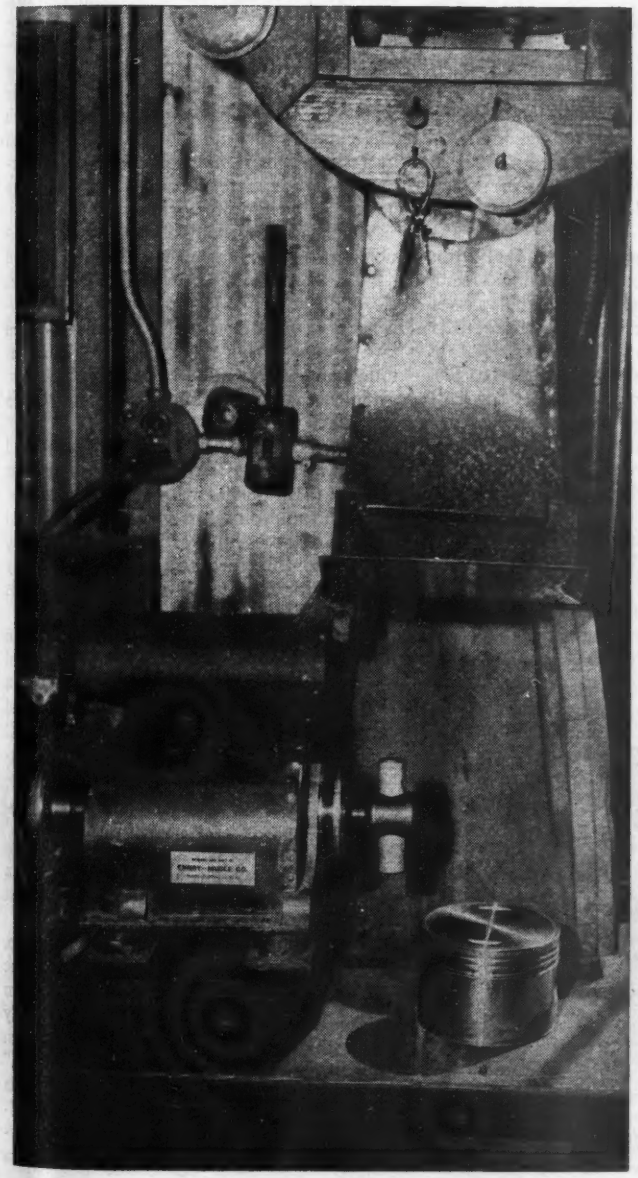
Sand-blasting cabinet with front door raised. Openings in door are to permit hands to be inserted without leakage of sand. Flaps at ends are to permit sand-blasting of long articles.



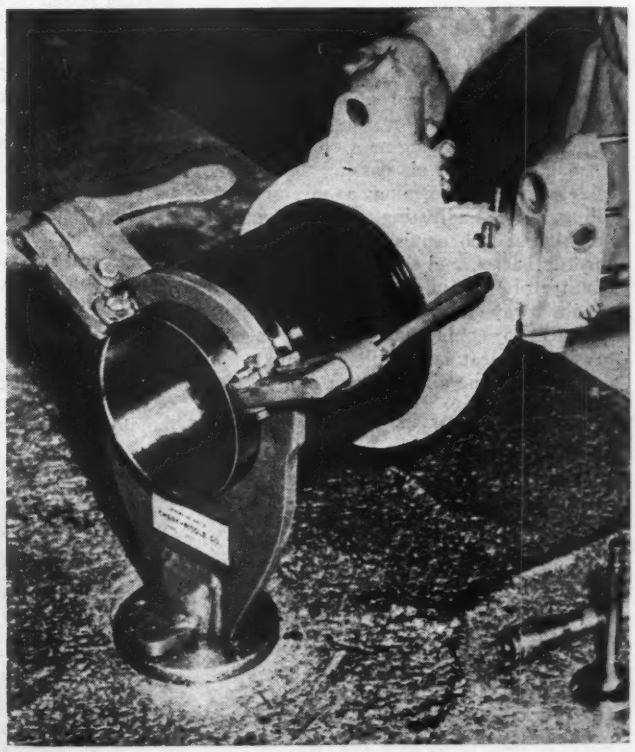
Standard belt sander is used to surface rocker box covers. By giving cover a half turn during operation, a smooth surface is obtained.



Master rod, crankshaft, and knuckle pin oil passages are cleaned by using this fixture, which applies any required pressure up to 150 psi. Plugs shown are used to direct oil flow to passage being cleaned.



Cylinder-holding bench fixture enables operator to retain cylinder firmly in any position while grinding valves, etc. Collet (right) is used to grasp valve stems while grinding.



Pistons are cleaned by this automatically centering chuck with use of an aluminum-covered steel pin to hold them in place. Blower above machine removes dust and dirt.

Operation and Adjustment Of Marvel-Schebler Carburetors

Herein, each part and action of the popular Model MA-3A is described, then procedure for hot and cold starts is detailed.

REFERRING TO accompanying detail drawings, when the throttle (28) is slightly open to permit idling, the suction above the throttle on the manifold side is very high. Very little air passes through the venturi (34) at this time, and hence, with very low suction on the main nozzle (36), it does not discharge fuel. This high suction beyond the throttle, however, causes the idle system to function, since the primary idle delivery (27) delivers into the high suction zone above the throttle. Fuel from the fuel bowl (15) passes through fuel channel power jet (44) into main nozzle bore (37), where it passes through idle supply opening (41) in main nozzle through idle fuel orifice (42) in idle tube (43), where it is mixed with air allowed to enter idle tube through primary idle air vent (14) and secondray idle air vent (13).

Resultant rich emulsion of fuel and air passes upward into idle emulsion channel (25), where it is finally drawn into throttle barrel through primary idle delivery opening (27), subject to regulation of idle adjusting needle (24), where a small amount of air passing throttle fly mixes with it, forming a mixture for idling. Idle adjusting needle controls quantity of rich emulsion supplied to the throttle barrel, and therefore controls the quality of the idle mixture. Turning needle away from its seat richens idle mixture to engine, and turning needle toward its seat leans idle mixture.

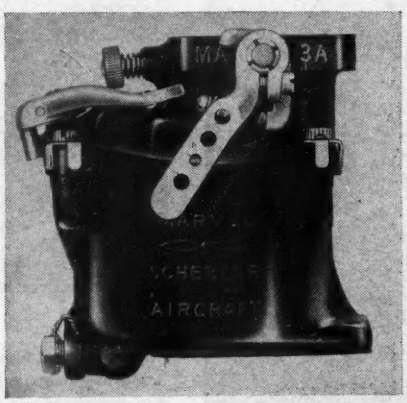
On idle, some air is drawn from throttle barrel above throttle fly through secondary idle delivery opening (29) and blends with idling mixture being delivered to engine, subject to idle adjusting needle. Secondary idle delivery begins to deliver idling mixture to engine as throttle is opened, coming into play progressively and blending with primary idle delivery to prevent mixture from becoming too lean as throttle is opened and before main nozzle (36) starts to feed.

Fuel delivery on idle, and at steady propeller speeds up to approximately 100 rpm., is from the idle system. At approximately 1,000 rpm., suction from increasing amount of air passing through primary (34) and secondary venturi (32) causes main nozzle (36) to start delivering, and idle system delivery diminishes due to lowered suction on idle delivery openings as throttle fly is opened for increasing propeller speeds, until at approximately 1,400 rpm. idle delivery is practically nil, and most of fuel delivery from that point to highest speed is from main nozzle.

Fuel feed at any full throttle operation is entirely from main nozzle. Idle system and main nozzle are connected by idle supply opening (41). Amount of fuel delivered from either idle system or main nozzle is dependent on whether suction is greater on idle system or main nozzle, suction being governed by throttle valve position and engine load. Main nozzle feeds at any speed if throttle is open sufficiently to place the engine under load, which drops the manifold suction. Under conditions of low manifold suction of throttle, main nozzle feeds in preference to idle system because suction is increased on the main nozzle by restriction of venturi.

Main nozzle is supplied with fuel from fuel bowl (15) through metering sleeve (19) and fuel channel (44). Fuel passes upward through nozzle bore where it is mixed with air drawn from nozzle air vent (35) and nozzle bleed holes (40) and discharged from nozzle outlet through nozzle air vent, then sweeps fuel from nozzle well (39) and nozzle bore under very low suction and therefore satisfies any sudden demand for fuel delivery. Nozzle and idle air vent entrance is provided with air vent screen to prevent clogging of vents with bugs and foreign matter.

To provide a leaner mixture for full economy in cruising range, back suction economizer is provided. This has no moving parts, consisting of connecting channels from throttle barrel to sealed fuel bowl. Economizer hole (10) at throttle barrel is located accurately with respect to throttle so that in cruising range this hole is brought into communication with the manifold suction above throttle, which suction is transferred to sealed fuel bowl through economizer channels (9). Suction in economizer channels is modified by atmospheric bowl vent (11), which places on fuel bowl a differential suction between manifold suction and atmosphere. This diminishes fuel flow to nozzle and idle system.



Marvel-Schebler's Model MA-3A aircraft carburetor.

Altitude control consists of altitude control lever (5), to which is attached altitude metering valve assembly (16). Altitude metering valve assembly is provided at its lower end with altitude metering valve (17), which rotates in stationary altitude metering sleeve (19). Altitude metering sleeve has slot through which fuel enters. Fuel metering is accomplished by relative positioning of one edge of flattened altitude metering valve and one edge of slot in altitude metering sleeve (19).

When altitude control lever is in position nearest to carburetor flange, a full power mixture is provided for takeoff. To make mixture leaner for altitude compensation, altitude control lever is moved away from carburetor flange. With altitude control lever in the leanest position, sufficient compensation for 14,000 ft. is provided.

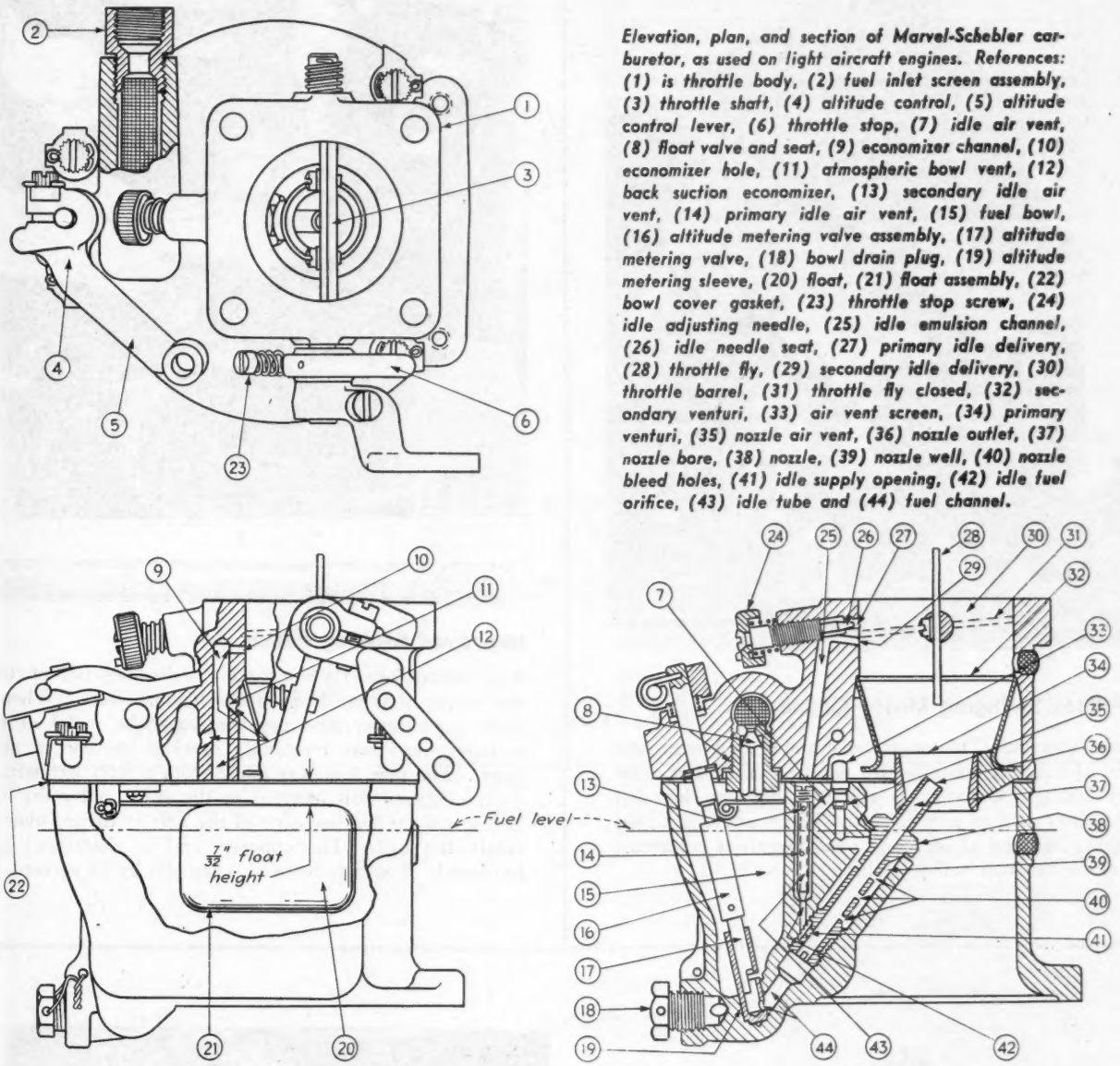
Altitude adjustment should not be used under 3,000 ft. When adjusting for higher than 3,000 ft. control should be moved in and out slowly with throttle full open until the highest rpm. is attained. Carburetor mixture will then be correctly adjusted for all throttle positions and loads at that altitude.

Altitude control should always be in full rich position, which will be in toward instrument panel when coming in for a landing. Thus if full power is required in an emergency near ground, engine will operate satisfactorily and will not overheat because of too lean a mixture.

Adjustment of Carburetor

If, after checking all other points on engine, it is found necessary to readjust carburetor, proceed as follows:

With engine thoroughly warmed up, set throttle stop screw (23) so that engine idles at approximately 550 rpm. Turn idle adjusting needle (24) out slowly until engine "rolls" from richness, then turn needle in slowly until engine "lags," or runs irregularly from leanness. This step will give an indication of idle adjustment range and of how engine operates under extreme idle mixtures. From



Elevation, plan, and section of Marvel-Schebler carburetor, as used on light aircraft engines. References: (1) is throttle body, (2) fuel inlet screen assembly, (3) throttle shaft, (4) altitude control, (5) altitude control lever, (6) throttle stop, (7) idle air vent, (8) float valve and seat, (9) economizer channel, (10) economizer hole, (11) atmospheric bowl vent, (12) back suction economizer, (13) secondary idle air vent, (14) primary idle air vent, (15) fuel bowl, (16) altitude metering valve assembly, (17) altitude metering valve, (18) bowl drain plug, (19) altitude metering sleeve, (20) float, (21) float assembly, (22) bowl cover gasket, (23) throttle stop screw, (24) idle adjusting needle, (25) idle emulsion channel, (26) idle needle seat, (27) primary idle delivery, (28) throttle fly, (29) secondary idle delivery, (30) throttle barrel, (31) throttle fly closed, (32) secondary venturi, (33) air vent screen, (34) primary venturi, (35) nozzle air vent, (36) nozzle outlet, (37) nozzle bore, (38) nozzle, (39) nozzle well, (40) nozzle bleed holes, (41) idle supply opening, (42) idle fuel orifice, (43) idle tube and (44) fuel channel.

lean setting, turn needle out slowly to richest mixture that will not cause engine to "roll" or run unevenly. This adjustment will, in most cases, give a slower idle speed than a slightly leaner adjustment with the same throttle stop screw setting. However, smoothest idle operation is thus obtained. A change in idle mixture will change idle speed and it may be necessary to readjust with throttle stop screw to desired point. Idle adjusting needle should be from ¾ to 1 turn from its seat to give satisfactory mixture.

Care should be taken not to damage idle needle seat by turning needle too tightly against seat, since damage will make for great difficulty in getting a satisfactory idle adjustment.

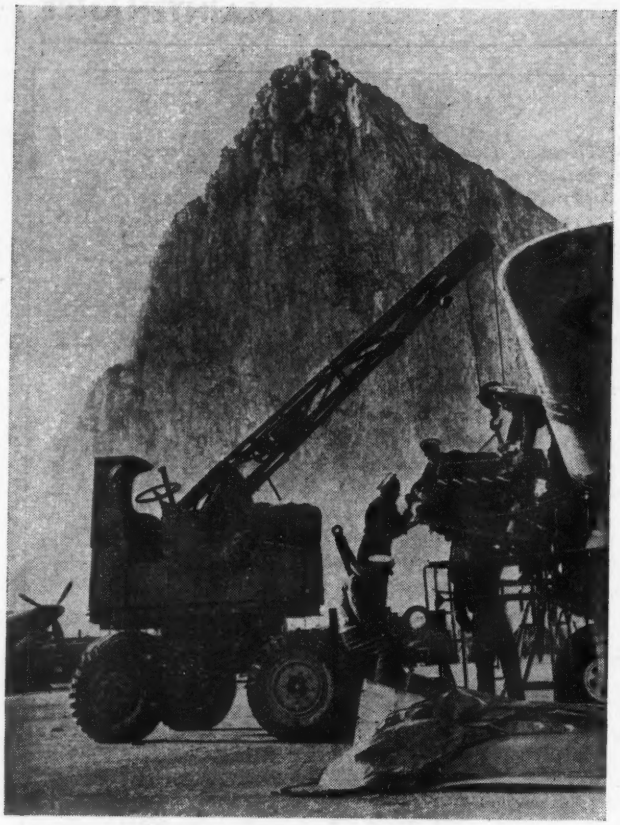
Float height, which is set at factory, can be checked by removing throttle body and bowl cover and float assembly (21) and turning upside down. Properly set, floats (20) should measure 7/32 in. from bowl cover gasket to closest surface of each float. Be sure to check both floats to proper dimensions, making certain that they are paralled to bowl cover gasket.

Starting—Cold Engine

Open and close throttle two or three times depending on air temperature, and set throttle stop approximately 3/32 in. from throttle stop screw. With throttle in this position, turn engine over two or three times before ignition is turned on. This will draw a finely emulsified mixture of air and fuel through manifold into combustion chamber, and then, if ignition is turned on, engine should start on next turn. And with throttle stop 3/32 in. from throttle stop screw there should be sufficient throttle opening to keep engine running. Carburetor is calibrated to give richest mixture at this opening, hence a cold engine will run smoothest with throttle in this position. For this reason engine should be allowed to warm-up for several minutes before opening throttle further.

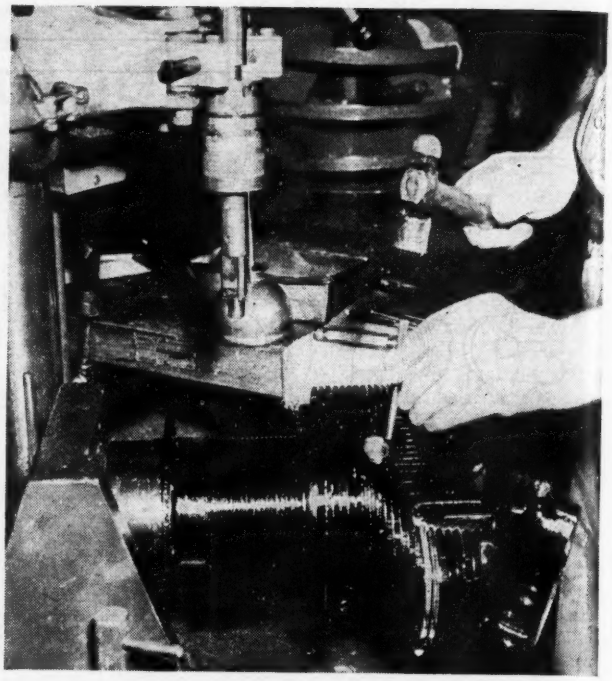
Starting—Hot Engine

To start a warm or hot engine, pull throttle stop against throttle stop screw in idling position. If engine has just been shut off, turn on ignition, then engine should start on first turn. But if engine has been shut off for several minutes it may be necessary to turn engine over once or twice before turning on ignition. A warm or hot engine should start and continue to run with throttle in idling position. If it does not do so, ignition should be checked.



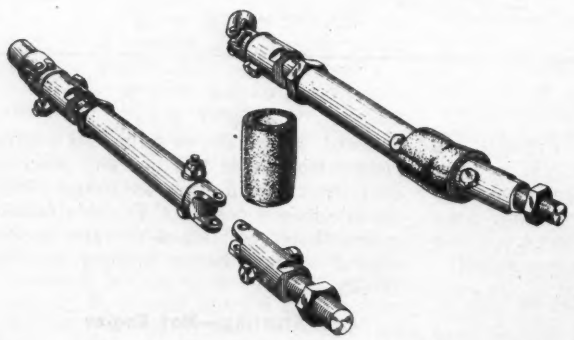
RAF Uses Swinging Motor Crane

• This "all-around" motor-driven crane is used by ground forces of RAF at Gibraltar for engine change and other heavy lifting. Capacity is equal to hoisting heaviest single units used on any aircraft. When crane is locked straight, fore and aft drive to road wheels is connected and crane becomes self-propelling.



Improved Staking Punch

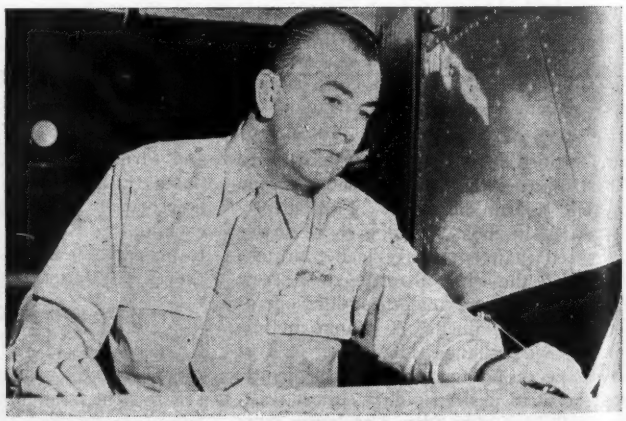
• Lycoming formerly had trouble in the operation of staking keeper pins used on spark plug bushings. When a prick punch was used for the work the metal of the cylinder head was frequently cracked because of slippage. The new tool was made from a steel bar with a $\frac{3}{8}$ in. hardened ball inserted in the end. After the ball is inserted the feather edge of the hole is turned over to retain the ball. The opposite end is chamfered and hardened. Tool has reduced scrap loss by 98 percent.



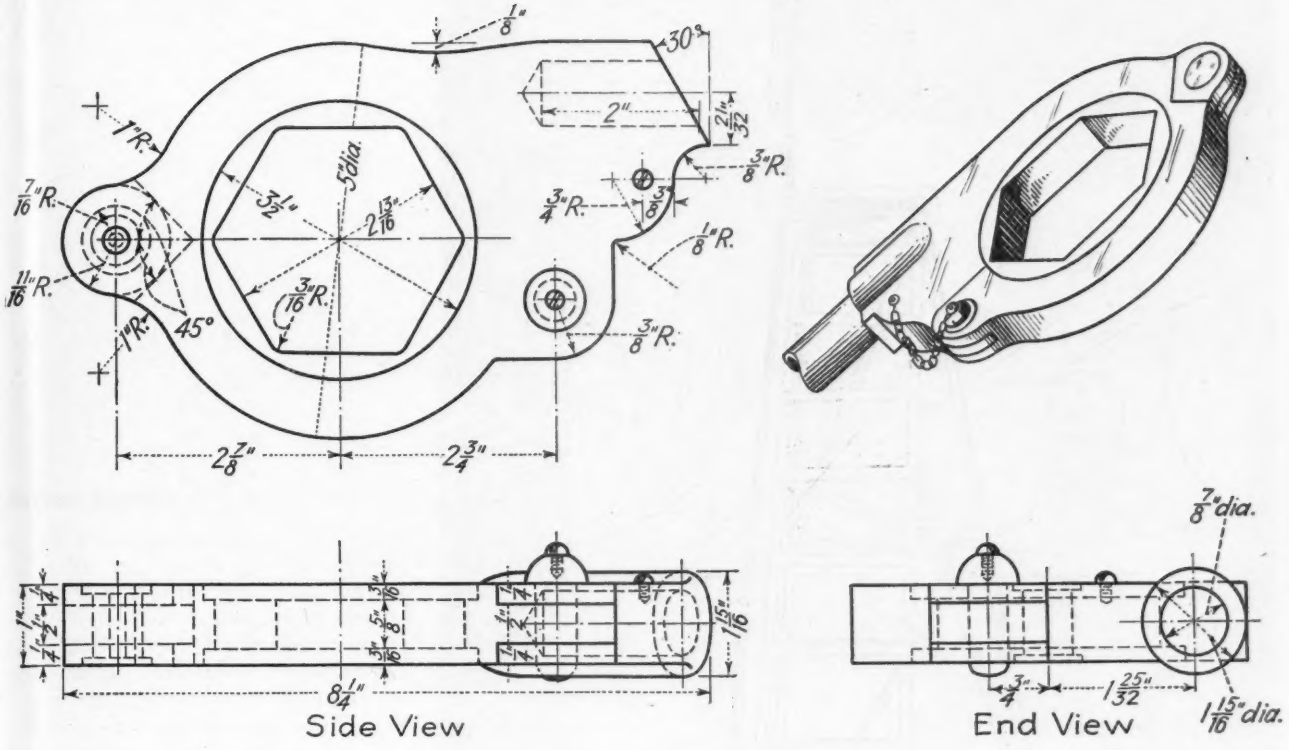
Southwest's Simple Safety Device

• "Three cent life insurance" is protecting planes and pilots at Falcon field, British Training School operated by Southwest Airways at Mesa, Arizona, where safety records for training flights have recently shown even better results than formerly.

And all because Maintenance Superintendent Joe Wischler was able to attribute a near crash to broken locking pins in the flap universal actuating joint.

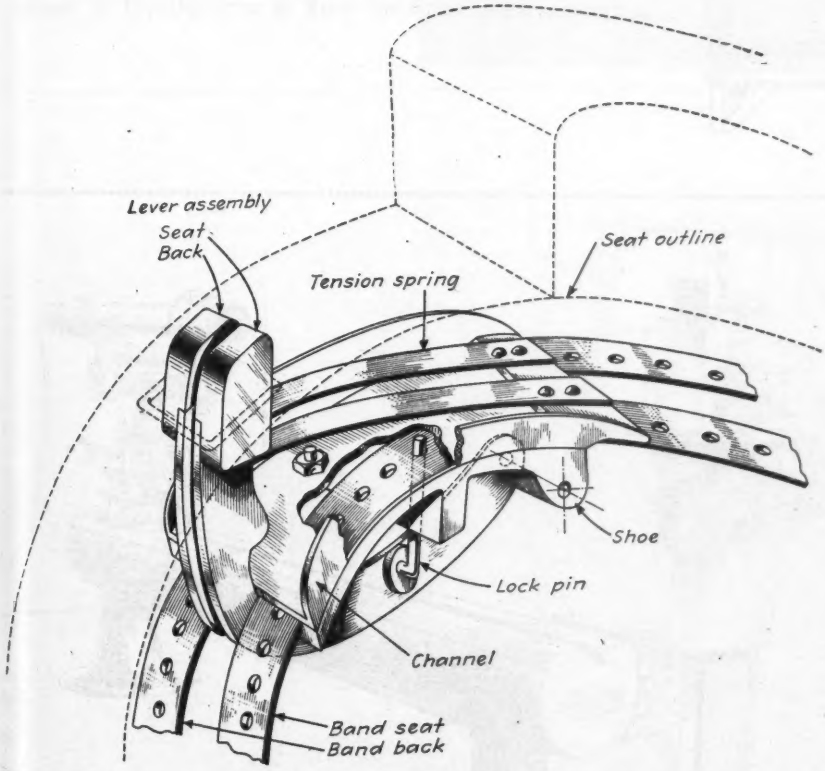


Wischler's solution to the problem is a three-cent length of common oil hose, $1\frac{1}{2}$ in. long and with a diameter of $\frac{3}{4}$ in. This flexible tubing slips over the flap universal actuating joint and seals locking pin segments in place even though they should break. Without the safety sleeve the broken pieces drop out and the assembly falls apart. But with the safety coupling in place operation of the flaps is not impaired even if pins do break.



American Airlines' New Governor Wrench

• By making wrench in hinged halves, AA saves much time in adjusting propeller governors.



United Improves Plane Seats

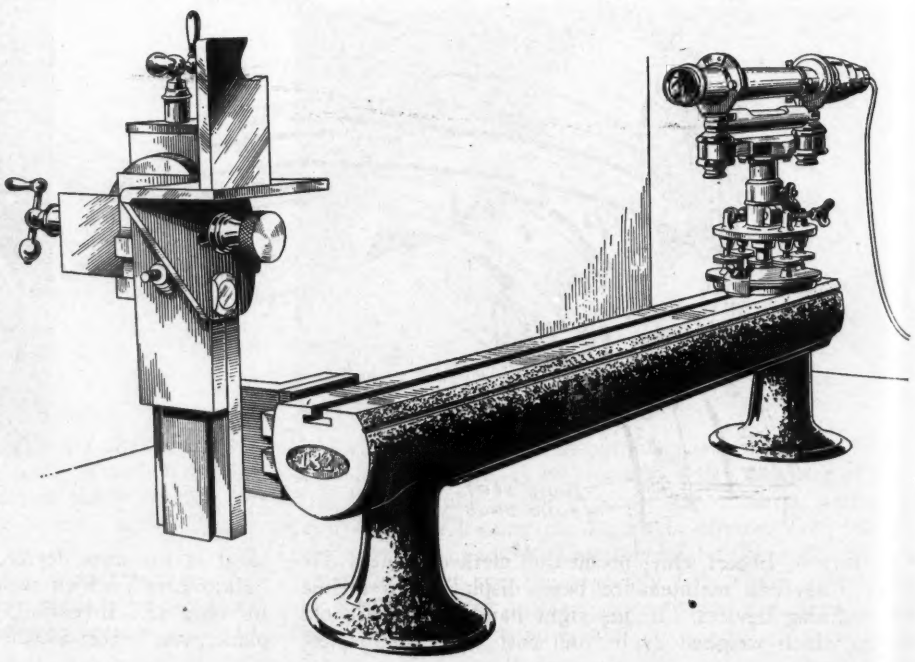
• Herbert A. Lebert, chief production clerk at United Air Lines' Cheyenne maintenance base, displays two airline seat-reclining devices. In his right hand is United's old device, which weighed 2¼ lb. and cost $45. In his left hand is his own device, adopted for use on all United "Mainliners", which weighs mere ¾ lb. and can be built for only $5. Invention, which saves 42 lb. in weight per plane, won Lebert $1,000 award. Sketch details device.

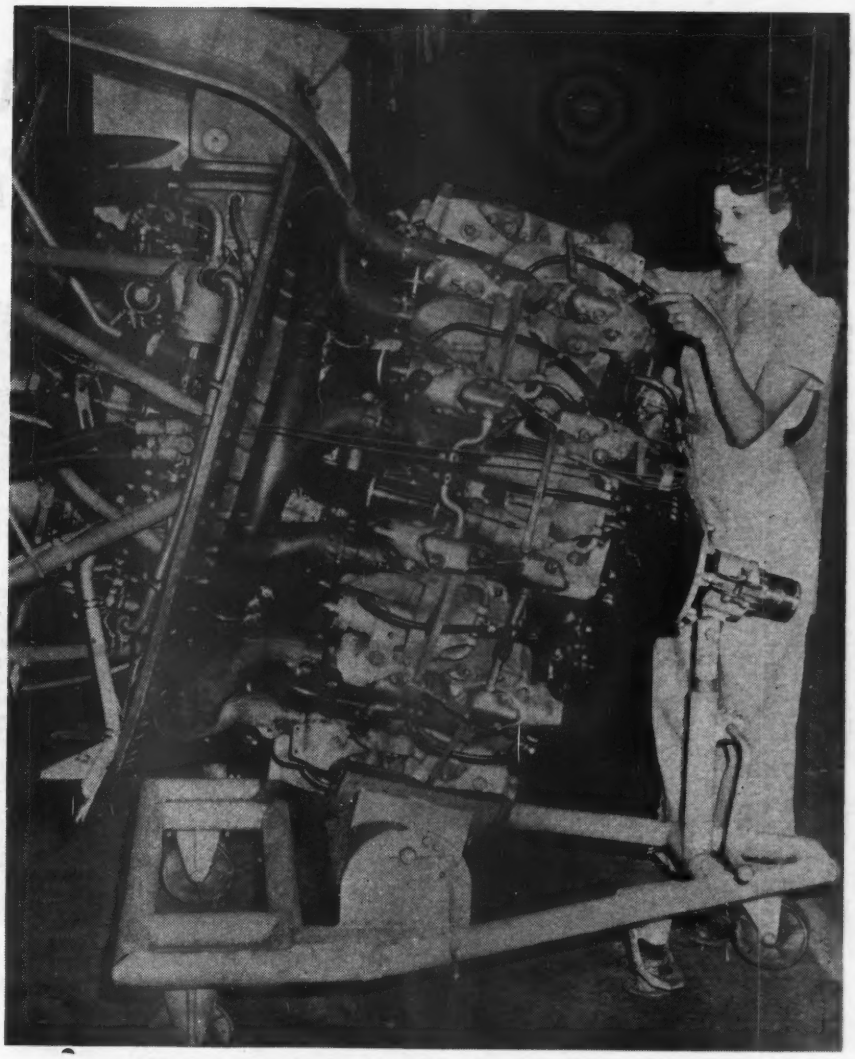
DC-3 Front-Entrance Stand

• A compact front-entrance stand was recently designed for TWA personnel. This stand (sketched here) is very light in weight, is portable, and may be used in conjunction with other equipment while servicing work is accomplished in hangar.

Device for Testing Avigation Octants

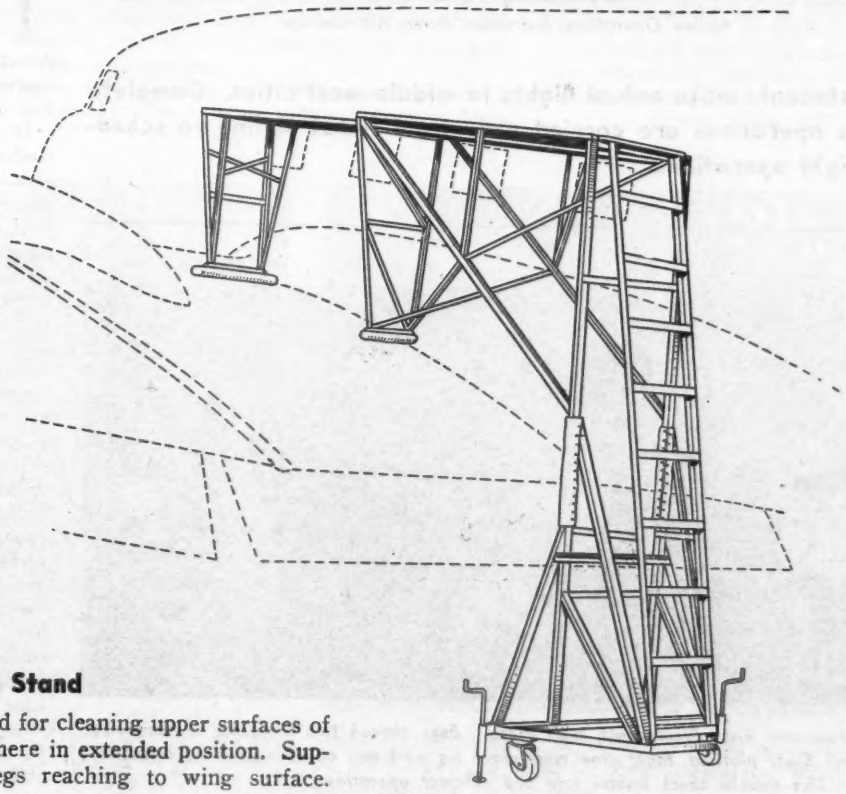
• Pan-American uses a surveyor's transit as an accurate means of checking octants used by avigators on their ocean-going *Clippers*. Octant to be tested is mounted at left on what was slide rest of the precision lathe which has been transformed into test stand.





Engine Cradle

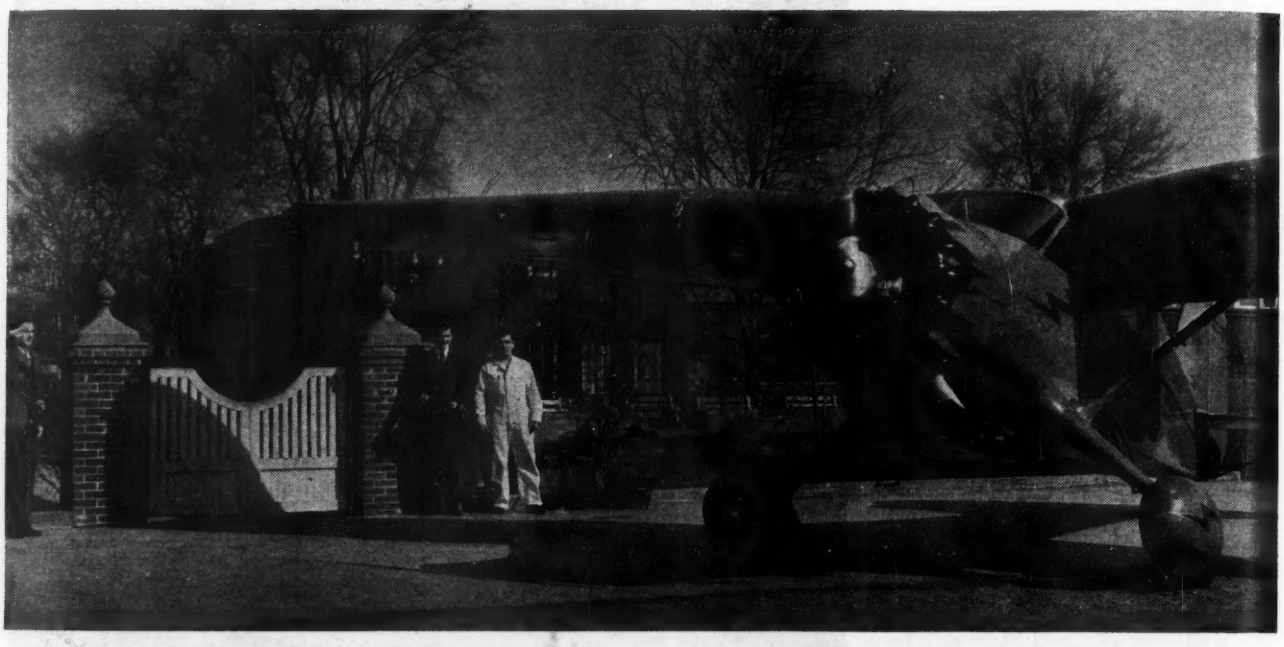
• Pan American developed this stand in order to provide greater accessibility than was the case with the old style angle steel frame. The engine rests on a rocking cradle and the propeller shaft is held by a hand-operated clamp which permits the engine to be tilted. A foot lock prevents the stand from moving when in use.



Fuselage Cleaning Stand

• TWA uses this stand for cleaning upper surfaces of DC-3's. It is shown here in extended position. Support is by padded legs reaching to wing surface.

PARKS STUDENT AIRLINE IS THE REAL THING



Simulating scheduled airline operating practice in all of its phases, students of Parks Air College have readied this Stinson "Reliant" for a trip to a midwest city carrying passengers, mail, and cargo.

By GENE KROPF
Airline Operations Instructor, Parks Air College

Parks students make actual flights to middle west cities. Complete airlines operations are carried out—from ticket selling to scheduled flight operations.

The captain and first officer check their maps. Even though trip navigator is responsible for correct flight plotting, flight crew must check his work and be able to make corrections enroute. This double check insures safe and efficient operation.

THIS SPRING the Parks Air College Airline began its tenth year. Operated and managed by the advanced Aviation Operation Engineering School students, PACA is the only non-profit airline in the country.

It came into being to fill a need for students in training—to give them actual airline experience along with their theory. Each year for a period of three months, PACA "employees" set up and run, in regular scheduled service, trips to four cities. Using East St. Louis as a base, flights are made to Chicago, Kansas City, Indianapolis, and Memphis. Students majoring in professional flight serve as Captains, and a properly licensed flight instructor acts as Co-pilot. The flights are operated on the same business-like basis as the regular airlines.

During the period of operations, the students are rotated through the various airline positions so they may secure actual experience in each. The length of time spent in any one position is determined by the number of students in the class or, if they intend to specialize, in any one of the various branches of operations or traffic work. Positions from Station Manager right along through the job of Line Mechanic are student responsibilities, and some of the problems presented to the station personnel would tax the ability of the most experienced operators.

The student Captain is required to have some 200 hr. to his credit by the time the airline term rolls around. The instructor pilot who serves as First Officer has thousands of hours in his log book and is well qualified to serve as check pilot.

Flight plans that are identical with those used by major lines are prepared by the Captain. Working in close harmony with the flight superintendent and the chief meteorologist, the captain carefully plots his course.

The Stinson "Reliant" used for all flights is equipped with twoway radio facilities, and a constant check is maintained between the aircraft and the ground station at St. Louis. Following his flight plan and using the various aids to navigation provided along the civil airways, the captain keeps his flight on a strict 2-hr. schedule. As the flight progresses, the captain enters a running log of the trip on the reverse side of the flight plan, thus providing a check on his operations. The captain is also responsible for checking the "Trip Forecast.' This is a form prepared by the meteorologists who chart all necessary weather information on the route to be flown. At the end of the trip, the captain is able to give the meteorologist helpful suggestions concerning this important form.

The flight superintendent is responsible for the dispatch or cancellation of all flights, just as he is with the larger lines. Working with the captain and the meteorologist, his decision as to the status of the flight can be questioned only by the captain. All authorizations for gas loads, cargo loads, and passenger loads above the regular number, must originate with the flight superintendent. Since at least three trips are flown each week, his task is very similar to that of a flight superintendent with a major airline. He is

Final weather check before departure is made by captain, flight superintendent, and meteorologists. Late weather is studied, then a final decision is made on day's operation.

qualified to handle this assignment, however, for he has had nine months of theory in the operation and dispatching of aircraft.

The meteorologist, usually working in a shift with several assistants, is responsible for the drawing of all weather maps used during the operations. He must keep the other departments of the airline advised of the latest changes and work with the flight superintendent when it appears that a trip will cancel or hold. These students have received about nine months of meteorology, including airline forecasting, when they assume this important position.

This is one of the most responsible positions in the operations. Working under the supervision of a competent instructor, these students are encouraged to make their own decisions. Forecasting for the entire PACA system is done from the East St. Louis office, so they actually receive some experience in long-range forecasting.

Handling all of the radio contacts for PACA are the radio operators. These

Reservation control agent issues and accepts all passenger space for PACA flights. Master charts similar to those employed by airlines are used.

students are the holders of Federal Communication Commission licenses and are fully qualified to operate the type of equipment being used. A national receiver capable of picking up the airliner during its entire flight assures the station of accurate information concerning the flight. It also serves as a check on the radio work

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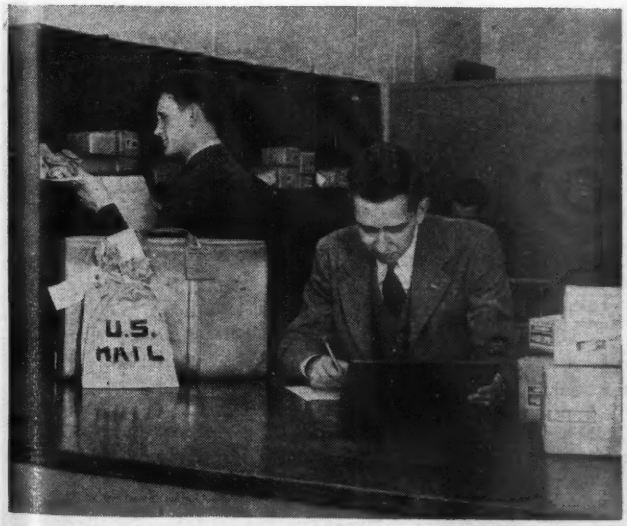

Accepting actual express packages and dummy mail pouches for shipment, these cargo agents prepare necessary forms and collect any charges involved in transaction.

Radio operator is shown sending and receiving reservation messages to secure continuing space for airline passengers. Both radio telephone and code are employed.

FLY-YOURSELF IS BIG BUSINESS

By HOWARD AILOR, *Founder, Ailor Fly-Ur-Self System, Inc., and now President of Aircraft Services Consolidated, Bloomsburg, Pa.*

It will cost more than a quarter and take lots of faith, says the man who operated America's only such service. Here he discusses problems, revealing what capital and equipment will be required.

PREDICTIONS regarding the "rosy" future of aircraft rentals (such as the "Fly-Ur-Self" service operated before the war by the writer) are becoming so numerous as to represent a definite threat to the financial solvency of many who might be sold on the idea.

First, let it be said that reasonable profits can and will be made from such Fly-Ur-Self operations. But, on the basis of experience gained through operating the largest such service in America before the war, it must be said— and said plainly —that running such a base is no bed of roses.

An examination of the problems reveals immediately that a fly-yourself base cannot be a shoe-string operation; it can't be set up on two bits and a lot of faith. First, there is the matter of flying equipment. Speaking again from experience, it must be reported a successful operation will require at least ten planes, all fully equipped for night and blind flying, all fully covered by insurance to protect the customer as well as the equipment. Moreover, this minimum of ten planes must embrace different types, including two-, three-, and four-place craft, with four of the latter—and most expensive—probably being needed.

Jolting as the need for the larger and more expensive planes may be from a financial standpoint, this type of equipment must be provided; for the writer's experience showed that about 80 percent of the business was done with craft renting for $15 or more per hour—the Wacos, Stinsons, Fairchild 24's, and similar sized planes. It is believed that under present conditions about 60 percent would represent a minimum ratio of such business to be done in the future, for repeat business generates mostly with businessmen to whom time and comfort are essentials.

While complete insurance coverage is essential, it should not prove an insurmountable obstacle. Our prewar business, which served to test a "guinea pig" policy, developed premium rates which were actually lower than current War Training Service rates. It is felt safe to assume that a growing volume of well-run, and consequently safe, self-flying business would bring about further premium reductions.

Assuming, however, that adequate finances are available to purchase and insure the required number of planes, there is another important financial matter to cover.

This involves establishing credit ratings, upon which courtesy cards can be issued to customers and prospects. It takes a lot of prospects to make a Fly-Ur-Self service, and it takes a lot of money to evaluate those prospects. In our prewar operations, for example, it cost $3.75 to get each courtesy card into the hands of the customer or prospect. This figure included investigations, which were made by two leading credit organizations; printing of questionnaires and identification cards; mailing and other direct charges. We found no way to short-cut this operation; the writer sees no way to operate in the future without similar investigations to establish a clientele with sound credit ratings.

In this connection, it should be pointed

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Postwar self-flying services will have to be sold just as they were before the war—and that means plenty of advertising aimed at a specific audience, as the author points out so clearly in this article. Here are samples of ads that worked successfully before the war.

Are Airline Stock Values Real?

By RAYMOND L. HOADLEY
Financial Editor, "Aviation"

Air transport revenues fluctuate with passenger load factors, and investors should be aware of the nature of present business and be prepared for a marked curtailment in the early postwar period. While remaining a first class investment, appreciable returns on airline stocks may be realized only in the long future.

QUESTION: Are investors in the airlines prepared for the postwar adjustments facing this industry? If not, the airline stocks are likely to sell much lower than they do today.

Large numbers of investors have bought airline stocks in the last two years in anticipation of the coming golden age of air transportation. But many of them do not realize (1) that this golden age may be nearly a decade away as far as big earnings and dividends are concerned, and (2) that the industry's problems of the next few years may have considerable influence on stock market prices.

Reams have been written about the adjustments facing the aircraft makers, while the romance of future expansion has had all the priorities when it comes to the airlines. True, the airlines' postwar problem is not one of survival because, unlike the aircraft manufacturers, these transport organizations generally are in satisfactory shape. The trouble is that the market probably has discounted, perhaps excessively, the problems of the aircraft group while failing to realize that the airlines, too, have adjustments to make that may have repercussions marketwise.

Public psychology, in and out of Wall Street, has always favored the airlines. Their steady growth, first in traffic volume and then in earning power, has made a favorable and lasting impression. But if a sudden and unexpected drop in earning power occurs after the war, as it probably will, the public may well sour on these stocks at present price levels.

Already American Airlines and Eastern Air Lines have reached the peak of their wartime earnings due to the excess profits tax. United Air Lines and several others are rapidly approaching the point where the excess profits levy will step in to put a ceiling on profits. Carry-over provisions in the tax laws no longer will keep them out of the excess profits tax brackets.

And in the case of the smaller lines, several already have shown a surprising drop in profits, even in wartime. Chicago & Southern, which Wall Street expected to earn around $350,000 in 1943, actually reported $128,000 against $277,000 in 1942. At the same time, Western Air Line's net profit dropped from $693,700 in 1942 to $90,000 last year.

Fact is that while the airline industry has made amazing strides in gaining its maturity, it has not yet reached full-bloom stability. Stockholders should not expect any miracles in those first postwar years. An expanding gross business will not necessarily mean expanding profits.

Present earnings are highly abnormal in relation to gross business. Current load factors of better than 90 percent can hardly be maintained under competitive peacetime conditions. Trade estimates place the postwar payload back around 60 to 70 percent. One accompanying table of statistics on payloads and earnings for the domestic airlines in the last six years shows the close relationship that always exists here. Some of the industry's most competent observers feel that the 1942-44 period will be looked back upon years hence as the most favorable operating period ever experienced.

Reductions in passenger fare and express rates last year, as well as cuts in airmail pay, may well prove to have been premature. It should be noted that many of the lines still are dependent upon airmail for a large part of their income. This is true even though for the industry as a whole airmail accounts for only 20 percent of revenues received while passenger fares provide about 70 percent. In 1931 mail provided 82 percent and passenger fares only 17 percent.

Not long ago the Civil Aeronautics Board retroactively adjusted the airmail rate of Braniff Airways. This decision cost shareholders about 35c. a share on 1943 earnings by reducing them to 61c. a share on the 1,000,000 shares outstanding. The sharp drop mentioned above in Western Air's 1943 earnings is attributable to a $500,000 decline in mail revenue, along with the 10 percent decrease in passenger rates and 12½ percent in express rates. Yet WAL passenger revenue was up 38 percent. Chicago & Southern, in turn, received a mail pay

(*Turn to page* 251)

How Earnings Follow the Payload

	Operating Profit	Rev. Pass. Load Factor
1938	*$1,016,508	50.43%
1939	4,556,205	56.20
1940	5,967,028	57.90
1941	7,392,000	59.13
1942	26,544,164	72.21
1943	31,753,000	88.01

* Deficit.

New Budd Steel Cargo Plane Has Many Unusual Features

Developed for Navy as cargo or troop carrier, "Conestoga" has exceptionally large freight compartment; two side doors would halve unloading time when used on paratroop missions.

CONSIDERABLE INTEREST attended the official unveiling of the E. G. Budd Mfg. Co. stainless steel cargo plane, the *Conestoga*, last month.

Marking a considerable departure from conventional design, the *Conestoga* presents a strange appearance to those accustomed to sleekness and straight lines. Characterized in aspect by a marked cockpit "hump", a tremendous afterbody upsweep and a liberal dihedral in the horizontal stabilizer, the ship has all the appearance of a flying boat on wheels.

However, the plane was conceived as a pure cargo type and all of its unusual features are fully functional. Principal objectives were to achieve an efficient flyable box-car, with dimensions of 8 by 8 by 25 ft., wholly unobstructed by structural members and capable of rapid loading and unloading.

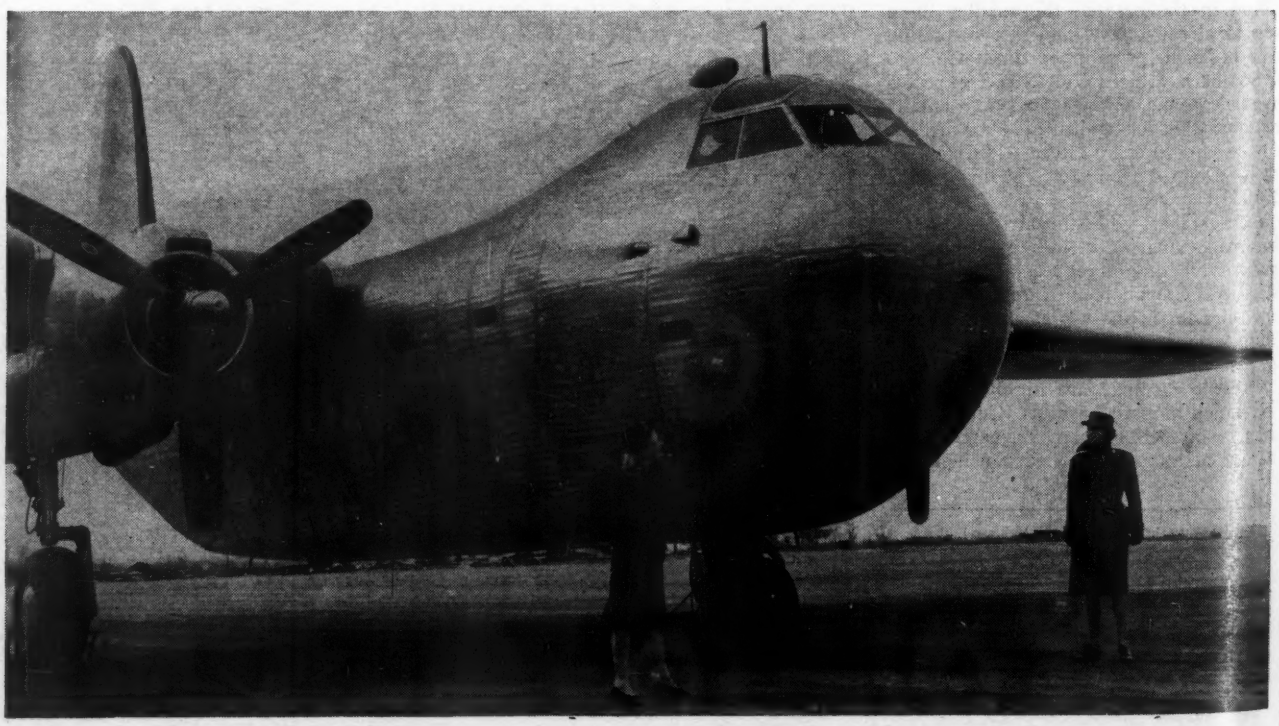
The designers settled on rear loading and a large hinged door was provided which lowers to the ground, forming a ramp for easy loading as well as an uncommonly large door area. In addition, sizeable doors are provided at each side of the fuselage. Tricycle landing gear maintains the compartment level on the ground, facilitating stowage. These features in combination with the large afterbody upsweep make it possible to load cargo of considerable dimensions. Provision is made for handling cargo with the aid of a hoist located at a roof truss just over the ramp, and a winch is located at the forward bulkhead so that heavy equipment may be hauled into the compartment.

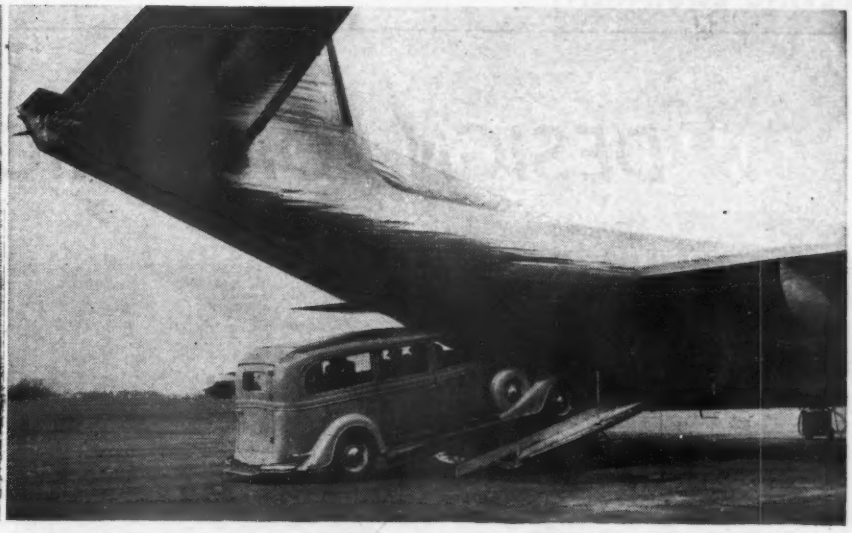
The cockpit "hump" is occasioned by provision of a flight deck of generous proportions. The deck is above the cargo level and is reached by a stairway adjacent to an entrance door on the left side of the fuselage, just forward of the cargo compartment.

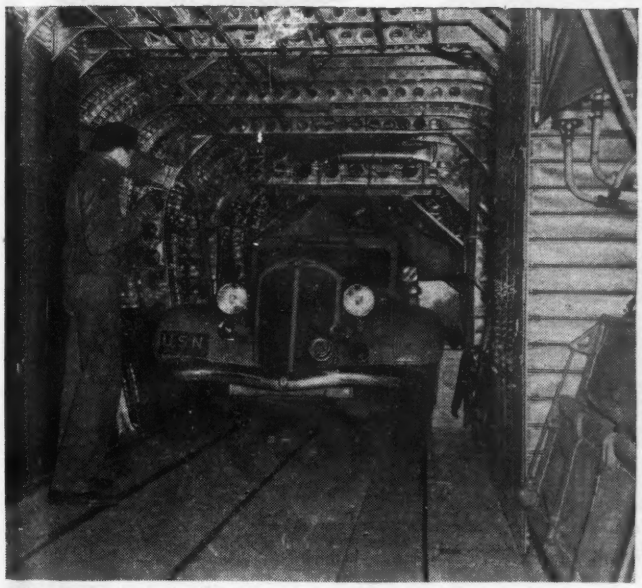
The *Conestoga* is fabricated of welded stainless steel virtually throughout. Its gross weight is 33,800 lb. of which 10,400 lb. is payload. It has a wing span of an even 100 ft. and is 68 ft. long. Equipped with two 1,200 hp. engines, it cruises at 165 mph. and has a normal range of over 600 mi. and maximum range of 1,700 mi. It is capable of takeoff with full load in 920 ft.

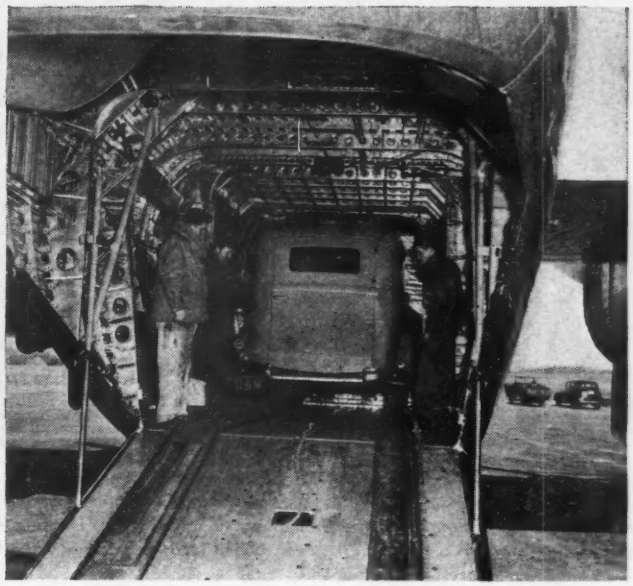
Although primarily a cargo carrier, the airplane can be converted to troop transport or aerial ambulance use. Provision is made for 24 seats and 24 stretchers. The two side fuselage doors would permit unusually rapid egress of paratroopers.

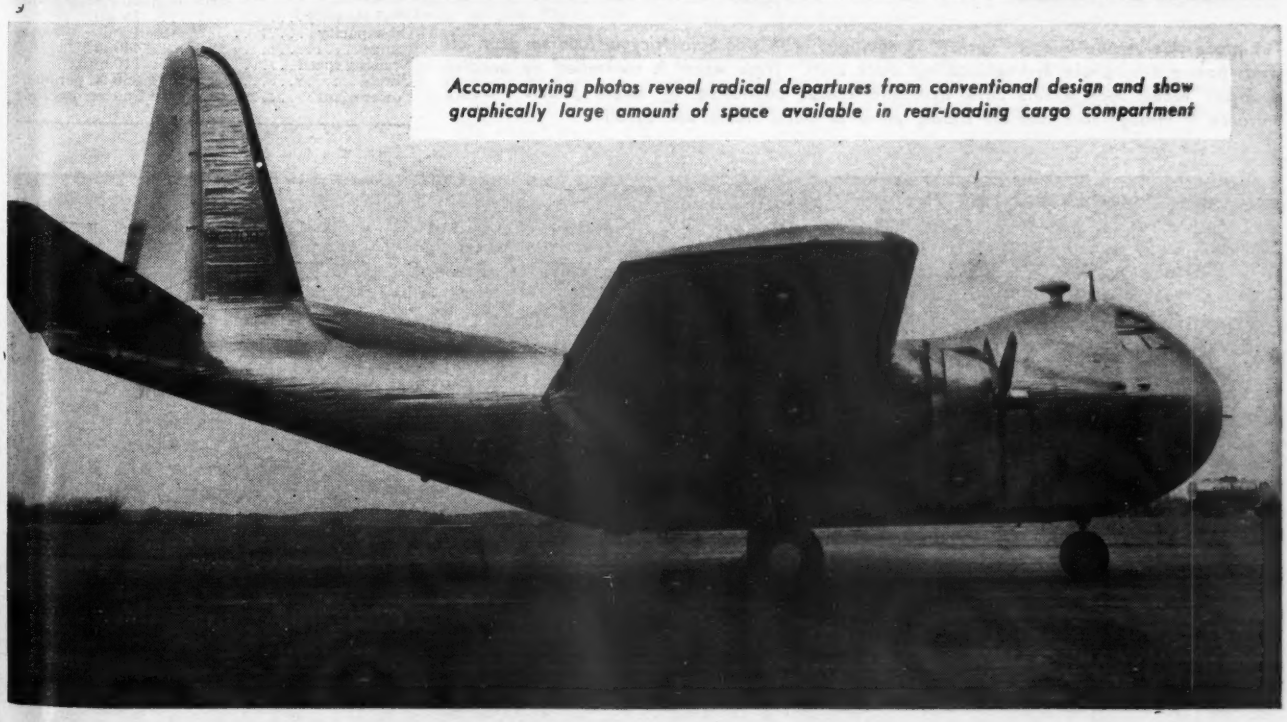
The *Conestoga* was developed under the sponsorship of the Navy Department, Bureau of Aeronautics, and is being built under a Navy contract.











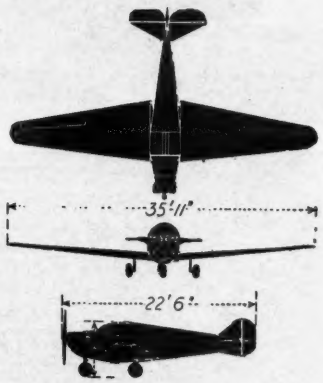
Accompanying photos reveal radical departures from conventional design and show graphically large amount of space available in rear-loading cargo compartment

DESIGN FOR TOMORROW

"Rocket" A-75, designed by William T. Gregg, president of Gregg Aircraft Mfg. Co., in flight. Plane is of aluminum alloy construction, with semi-monocoque fuselage from firewall to aft of cabin, full monocoque from there to tail post. Wings are full cantilever, stressed skin design, with two full length shear beams and detachable wingtip. With Continental A-75 engine, "Rocket" cruises at 110 mph.

Two-place side-by-side Gregg "Rocket" is equipped with steerable tricycle landing gear, all struts having 6-in. stroke hydraulic-spring shock units. Nose wheel is controlled by positive push-pull tubes; rear wheels have hydraulic brakes controlled by single pedal. Cabin entrance is through fore and aft sliding panel of dural frame and Pyralin.

The *Rocket* A-75

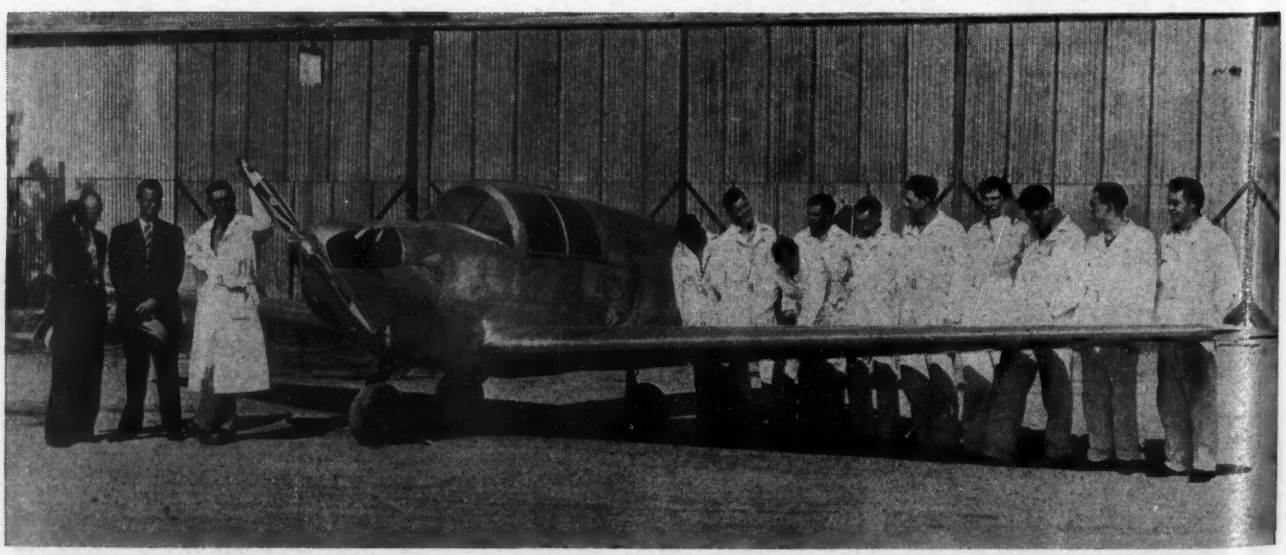


Three-view silhouette of "Rocket" A-75.

Rocket A-75

Specifications and Performance Data

Span	35 ft. 11 in.
Length	22 ft. 6 in.
Height, at cabin	6 ft.
Gross wt	1,275 lb.
Wt. empty	734 lb.
Wing section	NACA 23012 Tapered
Wing loading	8.03 lb./sq/ft.
Landing gear	steerable tricycle (single strut, 6-in. oil-spring stroke)
Fuel capacity	18 gal.
Oil capacity	1 gal.
Range	440 mi.
Cruising speed	110 mph.
Climb	850 ft. per min.
Power plant	one Continental A-75

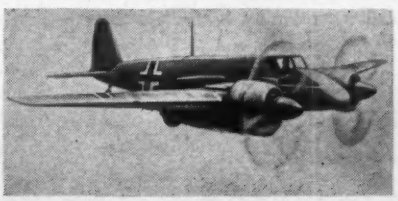


Captured Nazi Planes Yield Secrets

The "inside story" of enemy's newest aircraft types is uncovered as RAF puts captured craft in condition for thorough flight testing. Here, left to right, are shown Junkers Ju-88, Messerschmitt Me-110, Messerschmitt Me-109G; Focke-Wulf Fw-190A3; and Henschel He-129, latter still undergoing repairs and retaining German markings. (British Combine photo.)

RAF mechanics give "once-over" to 1,200-hp. Junkers "Jumo" engine of captured Ju-88, one of Luftwaffe's workhorse planes. Originally designed as a medium bomber, the type has been pressed into service as dive bomber, night fighter, and even as day fighter in desperate though futile attempt to stop AAF's 8th Air Force daylight attacks on Germany. Photo clearly shows "bathtub" arrangement, on lower right side of fuselage, used to house battery of machine guns and cannon. (British Combine photo.)

Close-up shows details of Messerschmitt Me-109G, latest in long line of type first combat-flown back in Spanish Civil War. Craft still retains comparatively narrow landing gear typical of this type, but spinner size has been greatly increased. Rounded air scoop set in side of cowling just above exhaust stacks was originally installed for desert operations of African campaign, but apparently it is now standard for all theaters. Power has been boosted from 650 in prototype to 1,600 in model shown above. (British Combine photo.)



Stripped Henschel Hs-129 reveals construction details of this ground-attack craft. Note Junkers-type "floating" ailerons similar to those used on Ju-52 transports, also fact that outer wing panel has but three ribs between tip and center section attaching point. Craft is powered by two 650-hp. Gnome-Rhone radials. Armament includes two 20-mm. cannon in nose and one 30-mm. cannon in belly. (British Combine photo.) Photo above shows how craft appears "unstripped" and in flight.

Engine Plant Grows Almost Over Night

Two-thousand horsepower engines are now coming, in Victory flow, from lines on ground which "hardly yesterday" was just peaceful Missouri Valley countryside.

ABOUT TWO YEARS AGO a small group of men stood in a field near Kansas City. Around them were farms and wire fences and white houses surrounded by trees. The only signs of life were the usual activities of rural Kansas.

Now, the same place is occupied by one of the largest engine plants in the world, already producing a large proportion of the highest powered aircraft engines made in this country.

If this achievement had merely been a matter of running up a huge group of buildings in record time, it would be worth recording. If the transformation of cornfields into a factory had been the only problem, its successful solution in less than two years would still be noteworthy. But though these two factors loomed largely in the task which lay ahead of the Navy and Army and Pratt & Whitney Aircraft, there were far greater obstacles to be overcome before the R-2800-C engines could flow off the assembly lines in that steady, never ending stream which is an accepted fact in American industry but is seldom or never seen elsewhere.

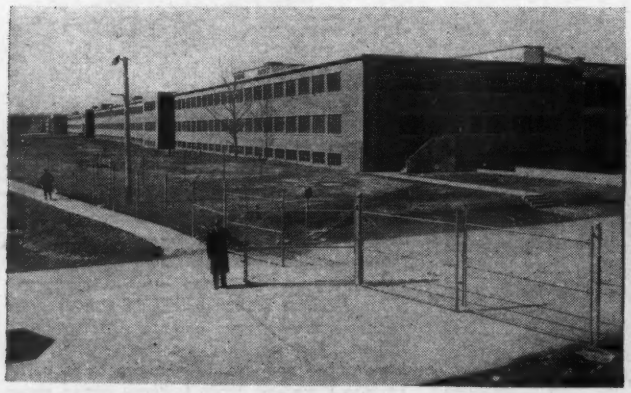
The buildings could be erected, there were sufficient engineers, designs had already been completed, but—who would build the engines? Where, in a preponderantly farming community, could nearly 30,000 mechanics be found? Let us quote Rear-Admiral Ramsey, Chief of Navy's Bureau of Aeronautics. " . . . we knew however, that we had in America four priceless resources . . . ingenuity, raw material, productive capacity and Americans who are independent, intelligent, resourceful and aggressive . . . capable of undertaking any task, no matter how alien to the work they had done in times of peace."

"Pratt & Whitney and the Bureau of Aeronautics knew how many engines we would want and how many thousands of former farmers, packing house workers, salesmen, housewives and others unfamiliar with precision tool work would be required, who must be trained to man such a plant and meet production schedules. . . . We needed light and power and heat and transportation for the workers —in a region largely agricultural we had to find trained mechanics to set up a training school to transform these sturdy Missouri Valley men and women into accomplished machine tool operators. Finally, we needed those intangibles that are a vital part of this country's greatness—"know how" and teamwork. We got them all. You see, we got those last two first—"know how" and teamwork—and, somehow or other, with those, the other problems resolved themselves, one after the other."

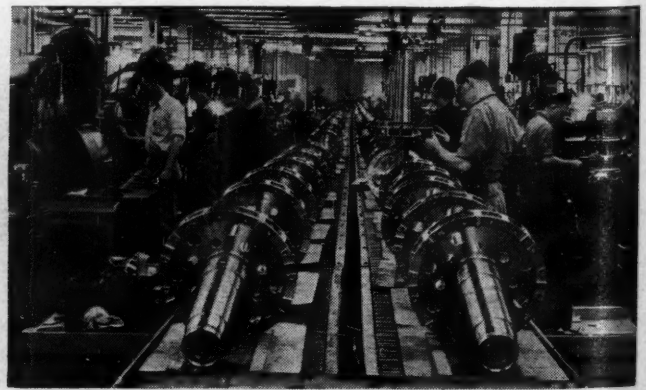
So the plant was built in a lovely valley about eleven miles from the city. While the buildings were being erected from non strategic materials, H. Mansfield Horner, president of the company had formed schools which taught those who were to become the mechanics in the huge workshops and the inspectors on whom the responsibility would rest of checking the output of one of the largest aircraft engine plants in the world. The results of this planning are best shown by what others say about them.

Speaking recently at Kansas City, Brigadier-General Perrin, AAF, said, "Every month Pratt & Whitney powered planes are flying millions of miles—across oceans and continents, over the Himalayas, in the cold of Russia and over the steamy jungles of the South Pacific . . . and having met this good old name of Pratt & Whitney all over the world, it seems natural to find it tucked away in the Missouri Valley, if you can really tuck away a plant covering three million square feet of floor space. Some day, and it can't come any too soon, we will start installing those new R-2800-C engines, made here in Kansas City, in the *Thunderbolts* and when that day comes the *Thunderbolt*, good as it is, will become a new airplane."

The work has not been easy. Tremendous problems were encountered and solved. But today, finished engines, in undisclosed numbers, are rolling off the assembly lines and taking their places as vital elements of the nation's first line of defense. Everyone concerned has a right to a deep feeling of satisfaction that so much has been accomplished so well.

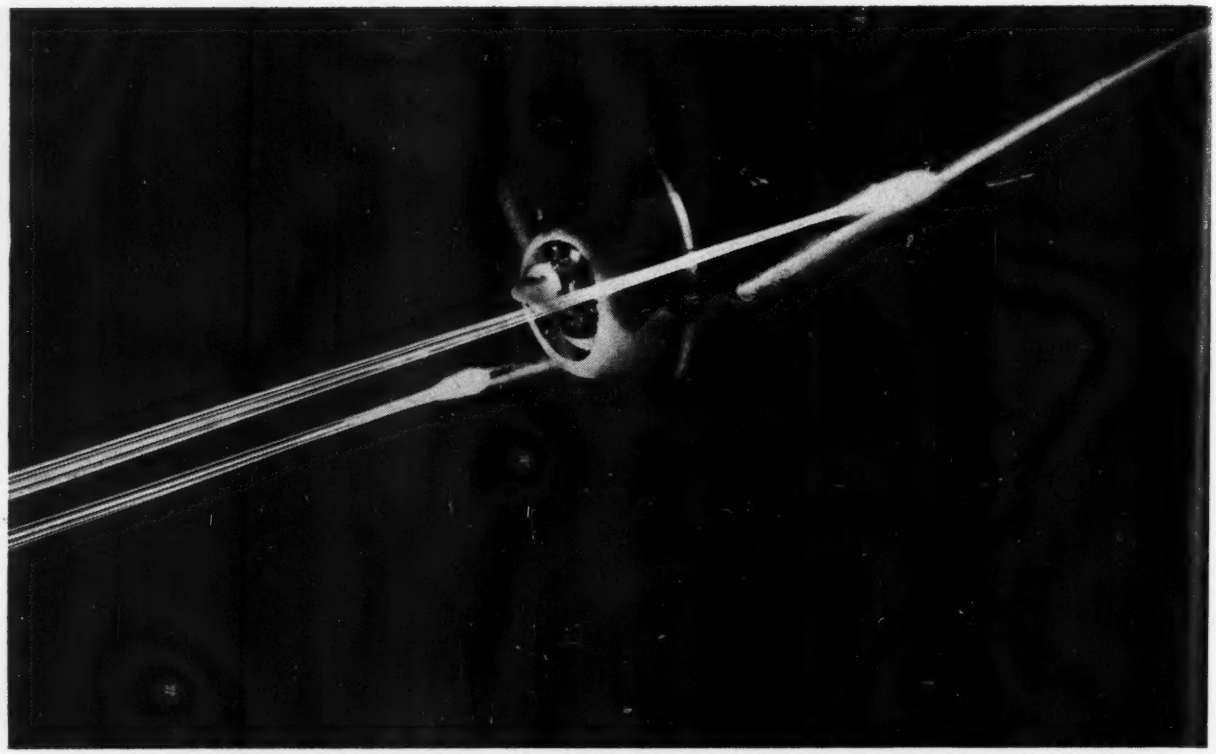


Three million square feet of menace to the Axis. P. & W. Kansas City plant where corn grew 20 months before.



Where this propeller shaft carrying belt now carries results of the work of hundreds of men, there was a field less than two years ago.

A WORLD'S CHAMPION HEAVYWEIGHT FIGHTER!
ON LIGHTER, STRONGER TIRES
UNITED STATES RUBBER COMPANY



The Thunderbolt Strikes!

With its eight 50-calibre machine guns blazing, the Republic Thunderbolt deals out destruction... establishing its claim to the title of a World's Heavyweight Champion among fighting planes. Developed in close teamwork with the AAF, the Thunderbolt is a high-flying fighter built to fly and fight in the stratosphere above 37,000 feet. Heavy armor protection, a mighty Pratt and Whitney engine with turbo supercharger and auxiliary fuel tanks for long-range bomber escort duty make the Thunderbolt the heaviest fighter that flies!

THE SCORE

At the main gates of the Republic Aviation Corporation plant at Farmingdale, Long Island, this scoreboard shows the deadly fighting power of the Thunderbolt. 993 enemy planes knocked out to 218 Thunderbolts lost. A ratio of better than 4½ to 1!

1230 SIXTH AVENUE **UNITED STATES**

NOW THOUSANDS OF POUNDS HEAVIER...
AND LIGHTER, STRONGER TIRES DO THE JOB!

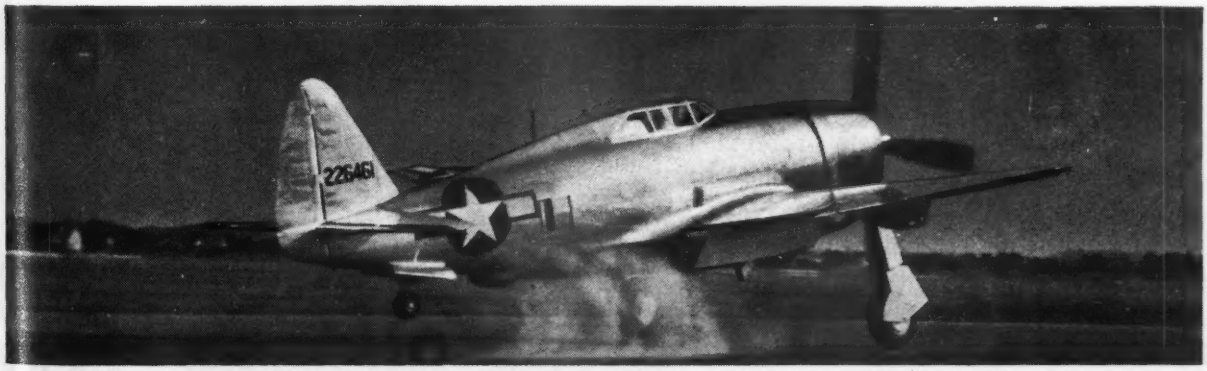
In 1941 the Thunderbolt weighed 12,500 pounds ... and it was a fighter then that earned the respect of any enemy craft. Today, with added armor and with auxiliary wing tanks and belly tank, the P-47 weighs in, fully loaded, at several thousand pounds heavier. To carry this great extra load at Thunderbolt speed on the same size tire, "U. S." tire engineers developed lighter, stronger U. S. Royal Airplane tires. With the constant cooperation of the AAF, tires were built with bodies of rayon and with treads of natural and synthetic rubber. Test after test in the laboratories and in combat have proved that these new, lighter, stronger U. S. Royal Airplane tires for landing wheels and tail wheels can do that job!

when the Thunderbolt takes off...

AIR-BORNE! With its full load of gas, the P-47 takes off. Under top load, the Thunderbolt's tires have done their first important job—to get this World's Heavyweight Champion Fighter away.

AWAY! The Thunderbolt is on its way to pile up another knockout score. Landing gear folding into place, the 2,000 horsepower supercharged engine takes over the job of climbing to fighting altitude.

and when it lands—



IMPACT! With a sock that sends out blue puffs of smoke, the lighter, stronger tires hit the ground—but with a trail of rubber scuffed off the tread from the sandpaper action of the runway. In this cruelest tire test of all, U.S. Royals are proving their ability to take it on Thunderbolts around the world.

RUBBER COMPANY ROCKEFELLER CENTER · NEW YORK 20, N. Y.

FOR THUNDERBOLT TAKE-OFFS AND LANDINGS
U. S. ROYALS ARE CHAMPIONS, TOO!

At AAF fighter bases all over the world, Thunderbolts are landing and taking off on U.S. Royals. United States Rubber Company is proud that Royals can play this important part in helping this World's Heavyweight Champion Fighter build up its fast-mounting fighting score. For safe, sure-footed performance, U. S. Royal Airplane tires—built lighter and stronger—are piling up a score that has earned for them, too, the title of champions among tires.

★

The U. S. Royal Block tread used on Thunderbolt landing wheels protects against forward and lateral skids, insures positive braking. The U.S. Royal Channel tread for tail wheels combines minimum bounce with pneumatic tire cushioning.

SERVING THROUGH SCIENCE...

TO SPEED THE VICTORY

UNITED STATES RUBBER COMPANY

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Review of Patents

By A. HARRY CROWELL, *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

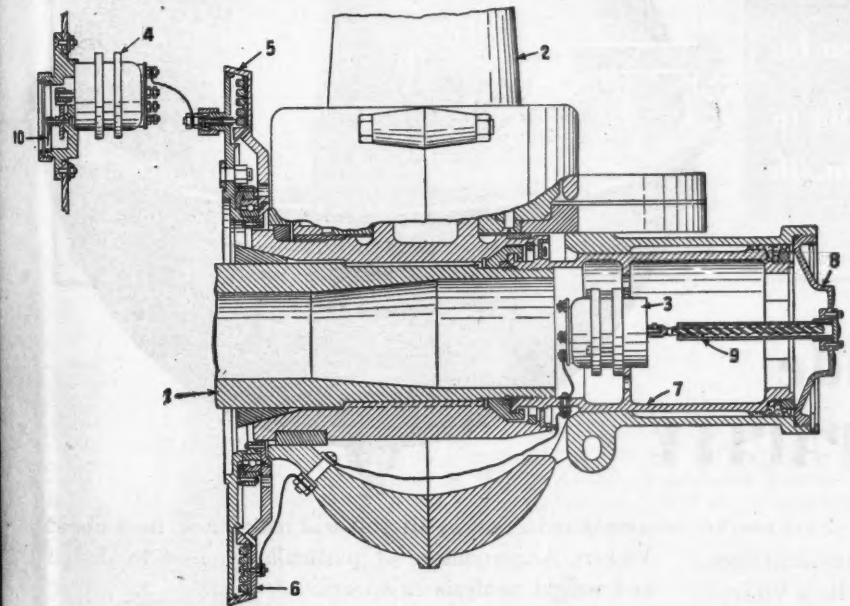
Aircraft Stall Indicating Apparatus also intended, in combination device, to warn of excessive speed which might cause structual failure through fluttering or other causes, is mechanism with appropriately counterbalanced air vanes disposed in airstream. Stall vane is a symmetrically pivoted about a generally horizontal axis so as to move up and down in response to changes in direction of airstream, while high-speed vane is responsive to velocity of airstream. Included is special arrangement of electrical contacts to transmit warnings to pilot.—2,337,753, filed Feb. 24, 1941, patented Dec. 28, 1943, R. D. Lacoe.

Signal Lamp, particularly for use on aircraft, is intended to improve safety of night flying at high speed. Device is described as having large luminous area, long range of visibility, and a wide spread to present signal light most effectively to sides, above, and below. To attain this result, reflector and cover glass are specially designed, and their arrangement in unit with respect to light source has been gaged for particular signalling efficiency. —2,339,243, filed Nov. 9, 1943, patented Jan. 18, 1944, C. Adler, Jr.

New Aircraft Wing employing two longitudinal spars, has three extensible portions rigidly interconnected between wingtip cap. These extensions can be moved outwardly to increase wing area (lift) during landings and take-offs, and each extension is designed to resist bending and twisting forces. First extension is positioned before front spar, second between two spars, and third in rear of back spar.—2,344,044, filed Mar. 15, 1941, patented Mar. 14, 1944, R. Koch, vested in Alien Property Custodian.

Portable Airfield of readily transported temporary type employs strips of metal woven together in a sort of basket weave and held to ground around outside borders by attachment thereto. Stresses applied to field are resisted by strips in tension rather than in bending. Strip units, of uniform size, are interlocked end-to-end to provide a long composite strip for weaving operation.—2,344,131, filed Feb. 18, 1942, patented Mar. 14, 1944, W. C. Coryell.

Bomb Releasing Rack. This rack, operable electrically or manually, is composed of an arrangement of parts to achieve operation with minimum energy in releasing substantially heavy bombs. Of light weight materials, operating parts are automatically set when a new bomb is positioned in rack.—2,344,211, filed May 21, 1942, patented Mar. 14, 1944, R. I. Markey, assignor to Pollak Mfg. Co.



Developed for use with controllable-pitch propellers, special position indicator mechanism, sketched here in layout form, is designed to show pilot pitch angle of his rotating propeller blades. Operation is via means for transferring pitch-change movements from airscrew blade to indicator. Drawing details cross section of controllable-pitch propeller hub, (1) being propeller drive shaft projecting from engine (not illustrated) and carrying propeller (2). Within pitch-changing mechanism is affixed unit (3) comprising relatively fixed stator and wound rotor within stator, and a similar unit (4) is secured to plane's instrument panel. When rotors and stators of these two autosyn-type units are electrically connected and two units are placed in circuit with source of electromotive force, then if there is rotation of rotor of one unit, the rotor of alternative unit rotates same amount. At (5) and (6) are ring-and-brush mechanisms to which, as indicated, there is connective wiring, respectively, from autosyn units (3) and (4), thus uniting them. In controllable-pitch action, member of mechanism (7) moves relative to member (8) which is interconnected, through screw shaft (9), to rotor of autosyn unit (3). Pitch movement registering in unit (3) is identically registered in unit (4) and, through gears, pointer (10) indicates pitch on suitably calibrated dial in cockpit.—2,337,613, filed June 7, 1940, patented Dec. 28, 1943, E. Martin, assignor to United Aircraft Corp., East Hartford, Conn.

Propeller Construction Patent calls for twin-blade airscrew fashioned from a single blank of double length, with the two integral blades having their connecting portion at propeller hub. Blades may have either no stagger at all or a very small stagger. A small stagger is stated to give a useful small overbalance which can overcome average aerodynamic moment. Two blades are connected by light weight stiffener members shaped to entail least possivle air resistance.—2,344,266, filed June 27, 1941, patented Mar. 14, 1944, H. Reissner.

Chute-Delivery Container is for transport of more or less fragile articles, such as rifles, machine guns, etc., by dropping them by parachute. Container is light in weight but rigid and strong when packed ready for dropping. After landing, release of a single quick-opening fastener will open entire container wide so that articles may be removed in a minimum of time.—2,345,609, filed Apr. 8, 1942, patented Apr. 4, 1944, W. L. Lindsey and H. Wilson, for free use by government.

(*Turn to page* 273)

Book Reviews

EMPIRE OF THE AIR, by Matthew Josephson. Harcourt, Brace & Co. 227 pages, illustrations, index. $3.

Mr. Josephson's first chapter starts bravely "On the Power Politics of the Air Age," posing the problems the world will face after the war. Best way to approach these problems, he says, "is to study the case history of Pan American Airways." Chapters II through XII do just that, offering a combination history of the line and biography of its president, Juan T. Trippe. Some of the material was previously published in a magazine serial. Chapter XIII, on "The Postwar Air," is a plea for reciprocity and cooperation which "must eventually be made worldwide" to establish global airlines and maintain the bases from which these airlines will have to operate."

THE LUFTWAFFE, by C. G. Grey. Faber & Faber, Ltd., London. 251 pages, photos, index. 8s., 6d ($1.75).

Appraisal of the German air forces from a British point of view. Traces the history of the Luftwaffe from its earliest beginnings as an outgrowth of the old Imperial air arm, with detailed attention given to the status of German aviation before 1914 and during the course of the first World War.

The latter half of the book treats of the Luftwaffe in its present stage of development. Grey greatly minimizes popular impressions of its size, power and flexibility, going on to express his strong belief, accordingly, that England never had much to fear from a German invasion. The reader may judge for himself whether the facts have borne out the author's analysis.

WORK METHODS MANUAL, by Ralph M. Barnes. John Wiley & Sons, Inc., N. Y. 136 pages, illustrations, charts, index. $1.75.

The author, a professor of industrial engineering, here undertakes "a guide for foremen, supervisors, and plant workers on the principles of work organization and motion economy," pointing up methods of doing mechanical jobs "with greater economy and efficiency, with less effort . . ." Pertinent chapters are: Job Breakdown, Process Charts and Flow Diagrams, Mechanized Process Analysis for Mechanized Production Lines, Man and Machine Charts, Motion Analysis, Tools. This is a detailed work for all machine-plant personnel.

A.S.T.M. STANDARDS ON RUBBER PRODUCTS. American Society for Testing Materials, Philadelphia. 424 pages, illustrations. $2.00.

Enlarged new edition. About 140 pages are devoted to the general methods of evaluating rubber, covering chemical analysis, sample preparation, accelerated aging, adhesion, cure, abrasion and tear resistance, hardness, compression set, changes in liquids. Latest specifications are given for aeronautical and automotive applications of rubber. Also included are War Emergency Provisions and Specifications.

(*Turn to page* 275)

VICKERS AIRCRAFT ACCUMULATORS

Save Weight

VICKERS 5" ACCUMULATOR
For 1500 psi Operating Pressure

Total Volume . . . . . 68.8 cu in.
(WITH DIAPHRAGM INSTALLED)
Weight, dry (COMPLETE) . . . . 3.50 lb
Volume/Weight ratio 19.7 cu in./lb

These accumulators comply with Winterization Specifications of the Army Air Forces for operation between —65°F and 160°F.

VICKERS 10" ACCUMULATOR
For 1500 psi Operating Pressure

Total Volume . . . . . 532.2 cu in.
(WITH DIAPHRAGM INSTALLED)
Weight, dry (COMPLETE) . . . . 14.95 lb
Volume/Weight ratio 35.6 cu in./lb

They also provide MAXIMUM CAPACITY

The weight saving in aircraft hydraulic systems resulting from the use of Vickers Accumulators is evident from the weights and volumes given above. We believe Vickers Accumulators have the highest volume/weight ratios of any accumulators available today. Maximum capacity is another important feature of Vickers Accumulators: the volumes of both the 5" and 10" sizes approach the high limits of the AN Accumulator Specifications.

The increasing importance of adequate evaluation of weight reduction in aircraft will make these facts about Vickers Accumulators of particular interest to design and weight analysis engineers.

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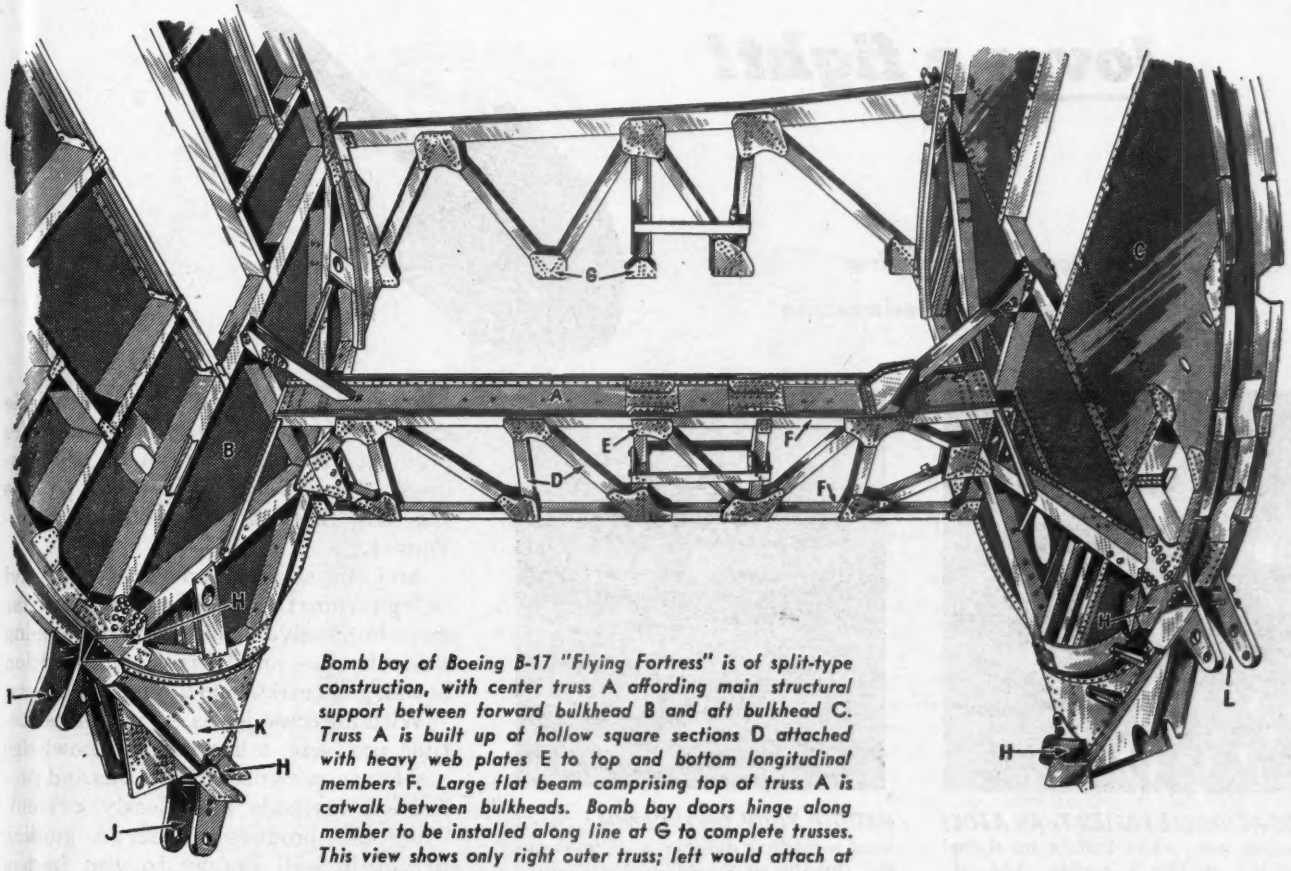
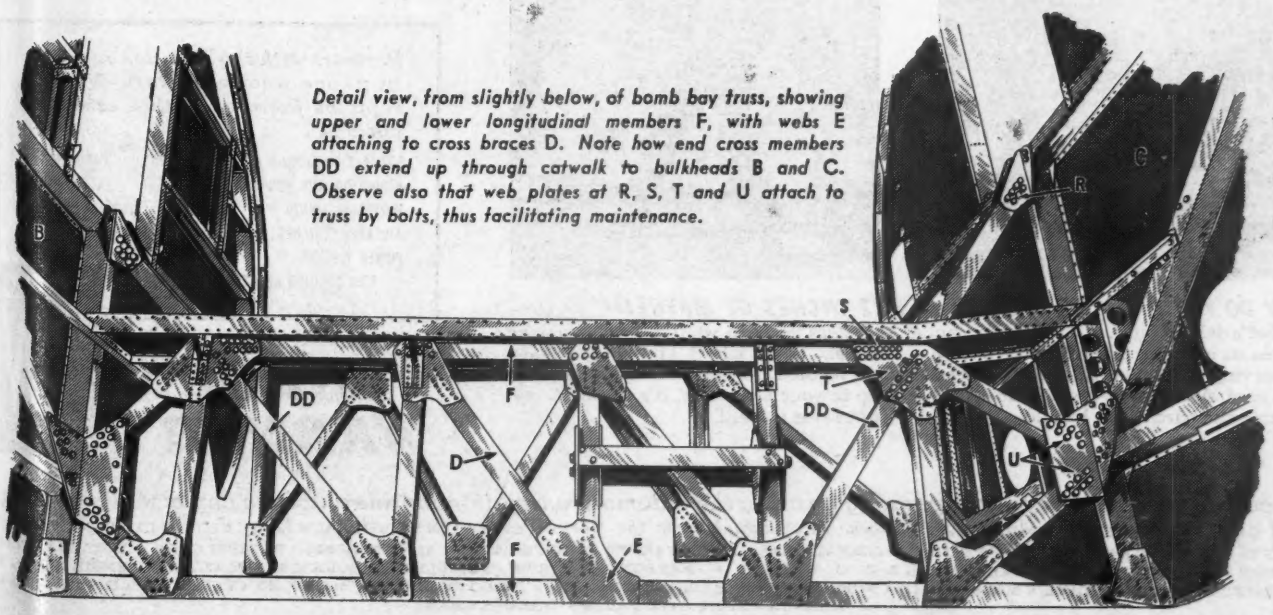


Bomb bay of Boeing B-17 "Flying Fortress" is of split-type construction, with center truss A affording main structural support between forward bulkhead B and aft bulkhead C. Truss A is built up of hollow square sections D attached with heavy web plates E to top and bottom longitudinal members F. Large flat beam comprising top of truss A is catwalk between bulkheads. Bomb bay doors hinge along member to be installed along line at G to complete trusses. This view shows only right outer truss; left would attach at fittings H. Front spar attaches to bulkhead through top fitting I and bottom fitting J, with load carried through to bulkhead by built-up section K. Top fitting for rear spar attachment is seen at L.



Detail view, from slightly below, of bomb bay truss, showing upper and lower longitudinal members F, with webs E attaching to cross braces D. Note how end cross members DD extend up through catwalk to bulkheads B and C. Observe also that web plates at R, S, T and U attach to truss by bolts, thus facilitating maintenance.

Foxy shovel that loves a fight!

American engineering gave it a college education!

DIGS A FOXHOLE FASTER THAN A FOX! You dig fast—when bullets are flying! You burrow like a gopher. And you thank your lucky stars for the keen, tough blade of that handy little shovel. The sarge was right—it's a lifesaver!

PADDLE YOUR OWN CANOE! You'd want something different at Poughkeepsie. But this shovel is O.K. for paddling in the pinches. It's rust-proofed and won't reflect light. You dig it deep into the water . . . and heave-ho!

HOW DO YOU LIKE YOUR EGGS? It's no chef's delight but a foxhole shovel can double as a frying pan. Mighty handy for serving up hot beans, meat or eggs. The steel shank prevents the fire from burning the hard wood handle.

22 INCHES OF MAYHEM! At close quarters you can whip out your foxhole shovel. It's a killer! The blade's sharp and pointed. The cross bar handle won't slip in your hand. Yes, it's a foxy shovel that loves a fight!

We're just as proud of this foxhole shovel as we are of any of the items we're producing for war. Hundreds of thousands of them are being made by the Ingersoll Steel & Disc unit of Borg-Warner.

And the same standard of care and skill goes into their making as into the far more impressive looking war tools being made by us—amphibians, ammunition hoists, gun turrets and a hundred others.

With all these items, as in our peacetime products, a specialized knowledge and long experience with metals and production methods are clearly evident. They are produced under a guiding principle well known to you in the aviation industry who have done business with Borg-Warner—the principle "design it better—make it better".

The influence of this principle will continue to be felt in the days ahead through many products which we hope to build with you of the aviation industry.

Partners with the Aviation industry in peace and war, Borg-Warner supplies these and other essential parts . . .

HYDRAULIC, VACUUM AND FUEL PUMPS · CARBURETORS
REDUCTION AND PROPELLOR GEARS · ENGINE PARTS
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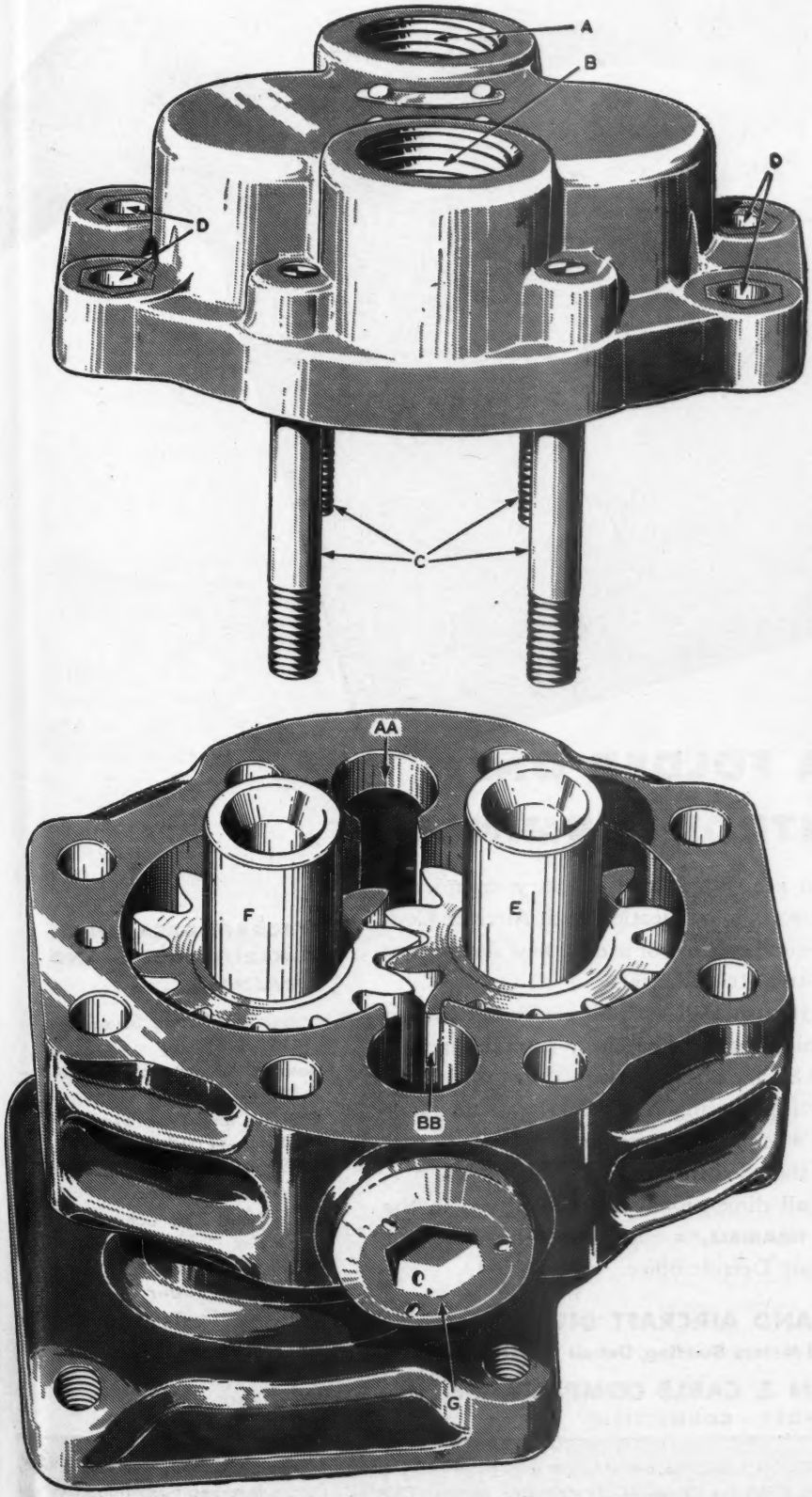
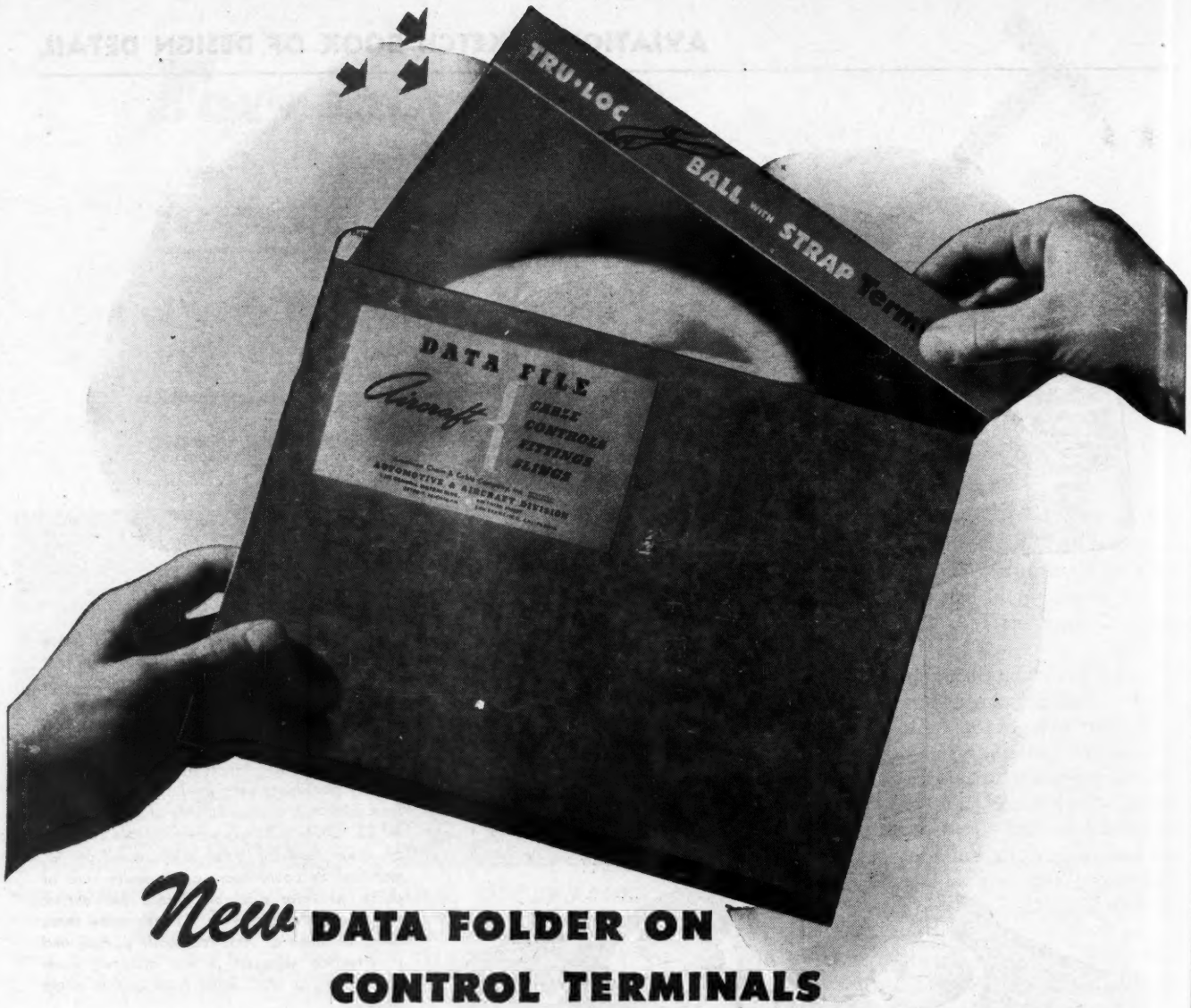
Peacetime makers of essential operating parts for the automotive, aviation, marine and farm implement industries, and of Norge home appliances . . . these units which form the Borg-Warner Corporation are today devoted exclusively to the needs of war: BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR AIRCRAFT PARTS • DETROIT VAPOR STOVE • INGERSOLL STEEL & DISC • LONG • MARBON • MARVEL-SCHEBLER CARBURETER • MCCULLOCH ENGINEERING • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • NORGE • NORGE MACHINE PRODUCTS • PESCO PRODUCTS • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR



Exploded view of oil pump from Japanese Mitsubishi 00 "Zeke" fighter. Cap, shown at top with intake A and outlet B, is of aluminum alloy and attaches to pump section by eight bolts—four, at C, screwed into cap itself, and four through holes, D. Pump section is bronze sand casting with gears E and F of high-quality well-machined steel. Flow of oil is from inlet AA around outside of gears to outlet BB. Drive is through gear F from coupling at lower end of gear bearing. Plug G, matched by counterpart on opposite side of pump, provides alternate intake and outlet. Whole unit weighs 3 lb. 11 oz., some three times as much as American-built pumps, and construction suggests it was adapted practically on "as was" basis from marine pump design.



New DATA FOLDER ON CONTROL TERMINALS

In line with the desire to keep all in the industry completely informed on new developments in connection with Aircraft Control Cable and Terminals—and method of use—a new data folder has been prepared on **TRU-LOC** Strap Fittings.

These fittings, used with **TRU-LOC** Ball-with-Single-Shank Swaged Terminals, provide terminals that are precisely interchangeable with AN 667 and AN 668 Swaged Terminals.

The original **TRU-LOC** Strap Fitting met all service demands made of it. But constant work with the product disclosed other advantages that could be included in a new design.

These advantages and all dimensional data are given in the new folder **"TRU-LOC STRAP TERMINALS,"** a copy of which will be sent you on request. Address our Detroit office.

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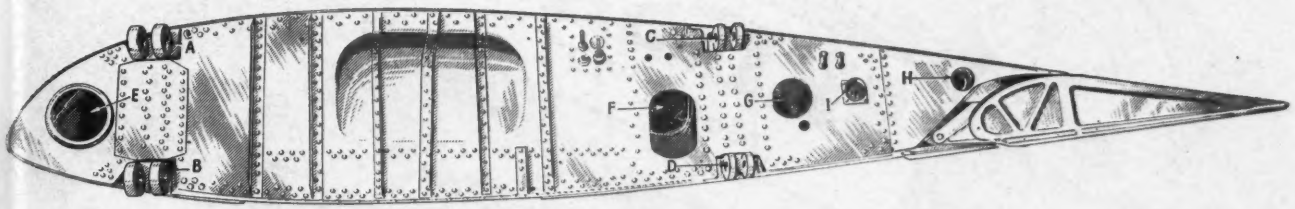
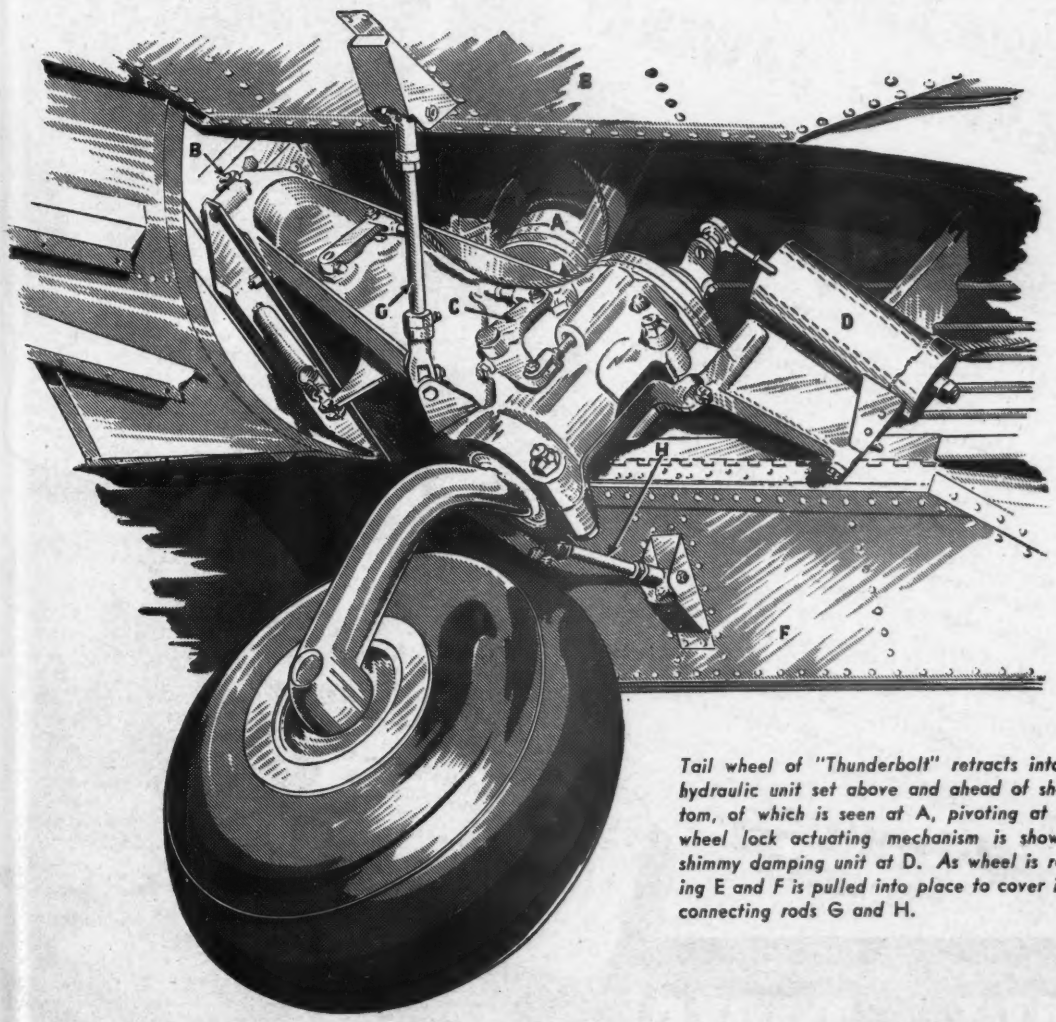


Inboard wing rib of Republic P-47 "Thunderbolt", showing fuselage attachment fittings at A, B, C, and D. Openings E, F, G, and H are for controls, with electric connecting plug set at I. Bulge in rib seen between attachment fittings forms inboard end of landing gear wheel well.



Tail wheel of "Thunderbolt" retracts into fuselage by hydraulic unit set above and ahead of shock unit, bottom, of which is seen at A, pivoting at point B. Tail wheel lock actuating mechanism is shown at C and shimmy damping unit at D. As wheel is retracted, fairing E and F is pulled into place to cover it by universal connecting rods G and H.

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Model "77"
It's the HANDIEST tool you can have for All HIGH-SPEED SAWING!
SKILSAW Speeds Metal Cutting in Production Work
• Cuts stainless steel faster . . . cuts copper sheets up to 5/8 in. thick . . . lead sheets up to 2 in. thick . . . saws channel steel up to 16 gauge and many types of corrugated metals.
SKILSAW Speeds Crating and Uncrating in Shipping Rooms
• Trims ends of crates in one quick cut. Ideal for uncrating because depth of cut is adjustable to prevent damage of contents. Goes right into freight cars to cut bracing lumber.
SKILSAW Speeds Maintenance Sawing Everywhere in Plant
• Rips out old flooring in a hurry . . . makes pocket cuts . . . grooves . . . speeds building of partitions, stairs, racks. Saves time on remodeling, with less delay to production.
• There are so many places around your plant where SKILSAW Model "77" can save time and money that you'll find it the best investment you could ever make.
On production work, SKILSAW Model "77" quickly cuts wood, sheet metal, plastics and compositions. In maintenance, it's the fastest, handiest tool for ripping up old floors, cutting lumber for bins and platforms . . . for cutting grooves for shelves. And in shipping or receiving rooms, SKILSAW Model "77" makes fast work of crating or uncrating without damage to contents.
This handy saw goes right to the job . . . saves time, material handling and money. It's light in weight, rugged, packs plenty of power for dozens of jobs in production and maintenance work. Ask your distributor to demonstrate SKILSAW Model "77" in your plant today!
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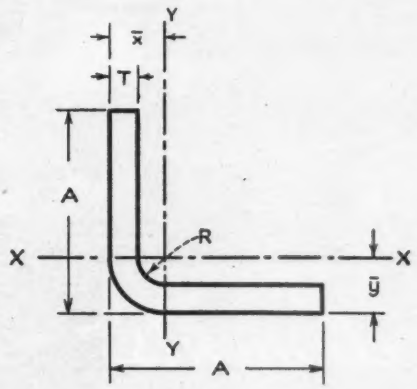
SHEET NUMBER DB-21
CLASSIFICATION . . . . . AIRCRAFT STANDARDS
SUB-CLASSIFICATION . . . . . ALLOY ANGLES

Below are listed latest N.A.S.C. standards for equal leg, aluminum alloy, rolled form angles



x & y — Locate center of gravity
I — Moment of inertia (inches⁴)
ρ — Radius of gyration (inches)

Material and length to be specified when ordering.

Weights shown are for 24S alloy.

Dash Numbers	Dimensions			Area Sq. In.	Weight Per Ft.	Dev. Width	Section Elements		
	A±.020	T	R±.010				M	I	ρ
1		.020	.020	.0193	.0235	.969	.134	.00034	.1334
2	.500	.025	.025	.0240	.0293	.963	.136	.00042	.1330
3		.032	.032	.0303	.0372	.947	.140	.00053	.1325
4		.025	.025	.0271	.0329	1.087	.152	.00061	.1497
5	.562	.032	.032	.0343	.042	1.071	.155	.00076	.1492
6		.040	.040	.0423	.0515	1.059	.159	.00093	.1485
7		.032	.032	.0383	.0468	1.197	.171	.00106	.1662
8	.625	.040	.040	.0474	.0580	1.185	.175	.00130	.1656
9		.051	.051	.0595	.0734	1.166	.180	.00161	.1647
10		.032	.032	.0423	.0514	1.323	.187	.00142	.1832
11	.688	.040	.040	.0524	.0640	1.311	.190	.00175	.1826
12		.051	.051	.0659	.0800	1.292	.196	.00218	.1817
13		.032	.032	.0463	.0563	1.447	.202	.00183	.1988
14		.040	.040	.0574	.0702	1.435	.206	.00228	.1994
15	.750	.051	.051	.0722	.0885	1.416	.211	.00285	.1985
16		.064	.064	.0893	.1103	1.395	.217	.00348	.1974
17		.072	.090	.0989	.123	1.375	.222	.00385	.1973
18		.040	.040	.0624	.0760	1.561	.2217	.00292	.2163
19		.051	.051	.0787	.0965	1.542	.2268	.00365	.2155
20	.813	.064	.064	.0973	.1200	1.521	.2330	.00448	.2144
21		.072	.090	.1080	.1342	1.501	.2380	.00496	.2144
22		.081	.101	.1202	.1501	1.484	.2425	.00549	.2137
23		.040	.040	.0674	.079	1.685	.2372	.00366	.2331
24		.051	.051	.0850	.100	1.666	.2423	.00458	.2322
25	.875	.064	.064	.1053	.122	1.645	.2484	.00563	.2312
26		.072	.090	.1169	.153	1.625	.2534	.00624	.2311
27		.081	.101	.1303	.162	1.608	.2579	.00692	.2304
28		.040	.040	.0774	.091	1.935	.2684	.00551	.2669
29		.051	.051	.0977	.115	1.916	.2735	.00691	.2660
30	1.000	.064	.064	.1213	.142	1.895	.2796	.00851	.2650
31		.072	.090	.1349	.157	1.875	.2845	.00937	.2649
32		.081	.101	.1505	.186	1.858	.2890	.01051	.2642
33		.091	.116	.1674	.209	1.842	.2940	.01163	.2635

(Continued on page 205)

PROVED against the elements

Furious tropical storms over steaming jungles . . . thin sub-zero atmosphere high above the earth . . . extreme velocities and excessive pressures . . . and the toughest combat conditions prove the dependability of Pacific Aircraft Actuators. These units apply positive punch-packed power to operate wing flaps, landing gears, bomb bay doors, and tail wheels on many of today's planes.

In the B-17 "Flying Fortress" built by Vega, Pacific Actuators open the bomb bay doors. The dependability of these remarkable power drives is the result of careful design, fine materials, and rigid tests.

The Pacific Model EL-1127 (illustrated) consists of Electric Aircraft Motor attached to a Pacific Multiple Gear Reduction with Friction Clutch. This Torque Shaft type actuator weighs but 22 pounds and delivers 420 inch-pounds torque at 300 r.p.m. output speed. Operating efficiently under temperatures ranging from −75° to higher than +135° F. Special provisions and proper lubrication assures top-notch performance under all conditions

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SHEET NUMBER . . . . . DB-21, cont'd.
CLASSIFICATION . . . . . AIRCRAFT STANDARD
SUB-CLASSIFICATION . . . . . ALLOY ANGLES

Below are listed latest N.A.S.C. standards for equal leg, aluminum alloy, rolled form angles

Dash Numbers	Dimensions			Area Sq. In.	Weight Per Ft.	Dev. Width	Section Elements		
	A±.020	T	R±.010				M	I	ρ
34		.040	.040	.0874	.105	2.185	.2996	.00790	.3006
35		.051	.051	.1105	.130	2.166	.3047	.00993	.2997
36		.064	.064	.1373	.162	2.145	.3108	.01225	.2987
37	1.125	.072	.090	.1529	.179	2.125	.3157	.01364	.2986
38		.081	.101	.1708	.210	2.108	.3201	.01516	.2980
39		.091	.116	.1902	.235	2.092	.3252	.01681	.2973
40		.102	.153	.2102	.261	2.074	.3323	.01856	.2972
41		.125	.187	.2522	.319	2.019	.3444	.02203	.2955
42		.040	.040	.0974	.118	2.435	.3309	.01089	.3344
43		.051	.051	.1232	.146	2.416	.3360	.01371	.3335
44		.064	.064	.1533	.181	2.395	.3420	.01694	.3325
45	1.250	.072	.090	.1709	.200	2.375	.3469	.01889	.3324
46		.081	.101	.1910	.235	2.358	.3513	.02102	.3318
47		.091	.116	.2129	.261	2.342	.3563	.02334	.3311
48		.102	.153	.2357	.294	2.324	.3634	.02581	.3310
49		.125	.187	.2835	.356	2.269	.3753	.03075	.3294
50		.040	.040	.1074	.129	2.685	.3621	.01455	.3681
51		.051	.051	.1360	.162	2.666	.3672	.01834	.3672
52		.064	.064	.1693	.199	2.646	.3732	.02270	.3662
53	1.375	.072	.090	.1889	.222	2.605	.3781	.02533	.3662
54		.081	.101	.2113	.249	2.608	.3824	.02823	.3655
55		.091	.116	.2357	.290	2.592	.3875	.03137	.3649
56		.102	.153	.2612	.314	2.574	.3945	.03474	.3647
57		.125	.187	.3147	.394	2.519	.4063	.04151	.3632
58		.051	.051	.1487	.158	2.916	.3984	.02392	.4010
59		.064	.064	.1853	.218	2.895	.4045	.02964	.4000
60		.072	.090	.2069	.243	2.875	.4093	.03310	.3999
61	1.500	.081	.101	.2315	.284	2.858	.4136	.03691	.3993
62		.091	.116	.2584	.318	2.842	.4187	.04106	.3986
63		.102	.153	.2867	.355	2.824	.4256	.04553	.3985
64		.125	.187	.3460	.431	2.769	.4374	.05452	.3969
65		.051	.051	.1615	.192	3.166	.4297	.03052	.4348
66		.064	.064	.2013	.237	3.145	.4357	.03786	.4337
67		.072	.090	.2249	.265	3.125	.4405	.04230	.4337
68	1.625	.081	.101	.2518	.273	3.108	.4448	.04721	.4330
69		.091	.116	.2812	.345	3.092	.4498	.05257	.4324
70		.102	.153	.3122	.386	3.074	.4567	.05834	.4323
71		.125	.187	.3772	.470	3.019	.4684	.06999	.4307
72		.051	.051	.1742	.210	3.416	.4609	.03824	.4685
73		.064	.064	.2173	.256	3.395	.4669	.04748	.4675
74		.072	.090	.2429	.287	3.375	.4717	.05308	.4674
75	1.750	.081	.101	.2720	.322	3.358	.4760	.05927	.4668
76		.091	.116	.3039	.371	3.342	.4810	.06604	.4662
77		.102	.153	.3377	.416	3.324	.4879	.07335	.4661
78		.125	.187	.4085	.507	3.269	.4995	.08814	.4645
79		.051	.051	.1870	.227	3.666	.4921	.04717	.5023
80		.064	.064	.2333	.276	3.645	.4981	.05861	.5012
81		.072	.090	.2609	.308	3.625	.5029	.06555	.5012
82	1.875	.081	.101	.2923	.344	3.608	.5072	.07323	.5006
83		.091	.116	.3267	.400	3.592	.5122	.08164	.4999
84		.102	.153	.3632	.446	3.574	.5190	.09074	.4998
85		.125	.187	.4397	.544	3.519	.5307	.10919	.4983
86		.051	.051	.1997	.241	3.916	.5234	.05738	.5360
87		.064	.064	.2493	.295	3.895	.5294	.07134	.5350
88		.072	.090	.2789	.330	3.875	.5341	.07983	.5350
89	2.000	.081	.101	.3125	.368	3.858	.5385	.08922	.5343
90		.091	.116	.3494	.415	3.842	.5434	.09952	.5337
91		.102	.153	.3887	.478	3.824	.5502	.11067	.5336
92		.125	.187	.4710	.582	3.769	.5618	.13334	.5321

Side Slips

NOW I KNOW why they have bomb-sights on helicopters," writes a friend, and his evidence is the following news item: "The undertaking firm of Shannon, Shannon and Shannon, Dallas, Texas, with great plans for the postwar world, has asked permission to operate a helicopter ambulance and hearse service. S S & S would pick up business within a 600-mi. radius of Dallas and drop it with speed, mobility and comfort' at any hospital or cemetery in the U.S.A."

• Speaking of helicopters, want to ride in one? Here's one way to try, anyway: Two 15-yr.-old lads recently went fishing in a rented rowboat. One got off on a sand bar, the other took the boat and proceeded to get stuck in some nearby marshes, from which he was rescued by fishermen in a more or less conventional manner. His pal, however, spent several lonely hours on the sand bar until a Navy pilot spotted him and a helicopter was dispatched to effect the rescue, believed to be the first one. That historians may have the facts on this first, the pilot was Lt. (jg) W. C. Bolton of the Coast Guard; the rescuee was Harry E. Lundmark, of (as you might guess) Brooklyn.

••The pilot was very young, and very eager to get across and finish off the war. He'd pushed himself and the plane unmercifully. Even when they reached the jump-off base there was no let-up. The crew had barely completed fueling when he dashed from Operations with weather and clearance; the crew chief hadn't even slammed the door behind him as they taxied out, the very young and very eager pilot was so impatient that he pulled the wheels up just a shade too soon. The crew chief shuddered as he felt the prop tips take more than a good bite out of the runway; his teeth chattered in sympathy with the new vibration. But still the pilot kept pushing—right out over the drink toward war and real action.

Finally the chief could stand it no longer; he leaned over the pilot's shoulder and said, "Excuse me, sir, don't you think we should turn back and repair the damage?"

"To heck with it," the pilot replied, "let 'em fix their own runway."

• The field where the old timer kept his plane was often fogged in, but he didn't mind. His best friend's home was atop a hill—usually above the fog layer. The arrangement worked very nicely though—old timer would buzz the house, the friend would jump in his car with the spotlight pointed straight up and lead the way to a certain specified spot on the field and stop. Then the old timer would come in, all according to a well-practiced routine. The system was working beautifully one dusk until—the friend had a flat tire. Scrambling out to fix it as quickly as possible, he forgot to cut the spotlight; Old timer seeing it remaining stationary, came in for his usual half-blind landing. He walked away from the landing all right, but he had to crawl out from under a barn to do it.

• The furloughed officer, just returned via a big transport, was describing the crash landing they'd made in some very rugged country. "First," he said, "we lost the right outboard engine, then the left inboard went, then the right inboard—"

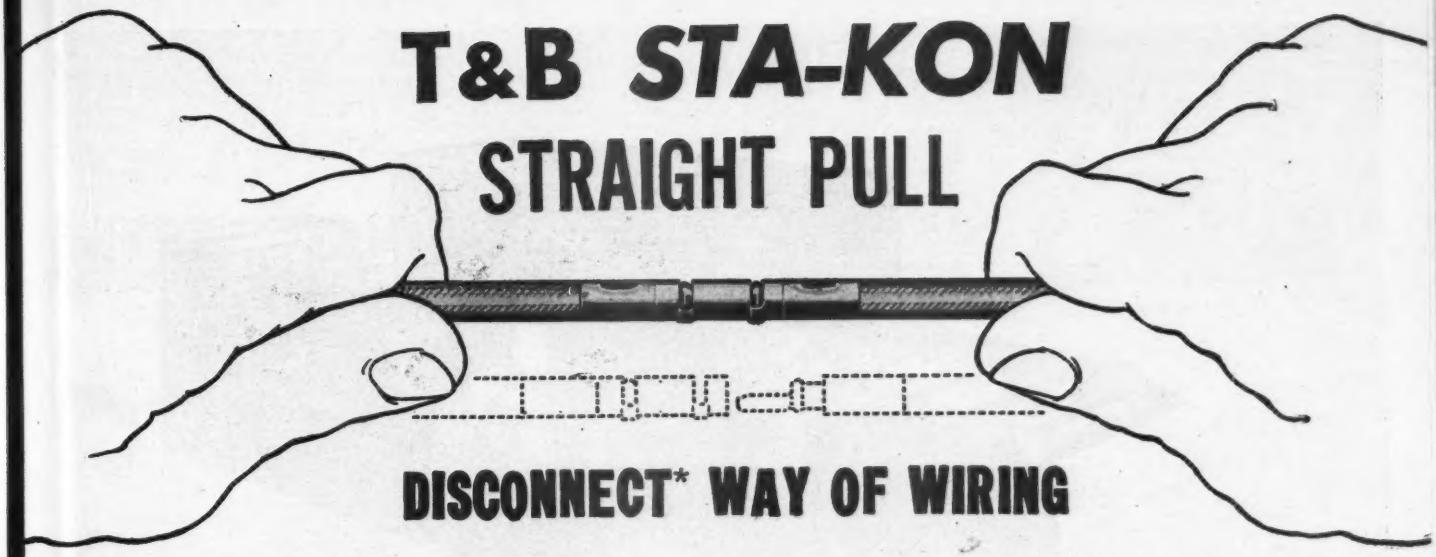
At which point the young lady cried, with some heat, "It's beyond me how you can admit it. With airplane engines as big as they are I just can't see how you could lose *one,* let alone mislay three!"

• It was a short-range ship, but the ferry pilot was trying to keep a tight schedule—fuel and get aloft again—even though his right landing gear was stuck in down position. After each takeoff, though, it meant long conversations with the control towers. Finally, when the 4th one called to report, "your right wheel is down, your right wheel is down," he replied wearily, "Yeah, I know, but I *like* to fly this way. Mind? Over and out."

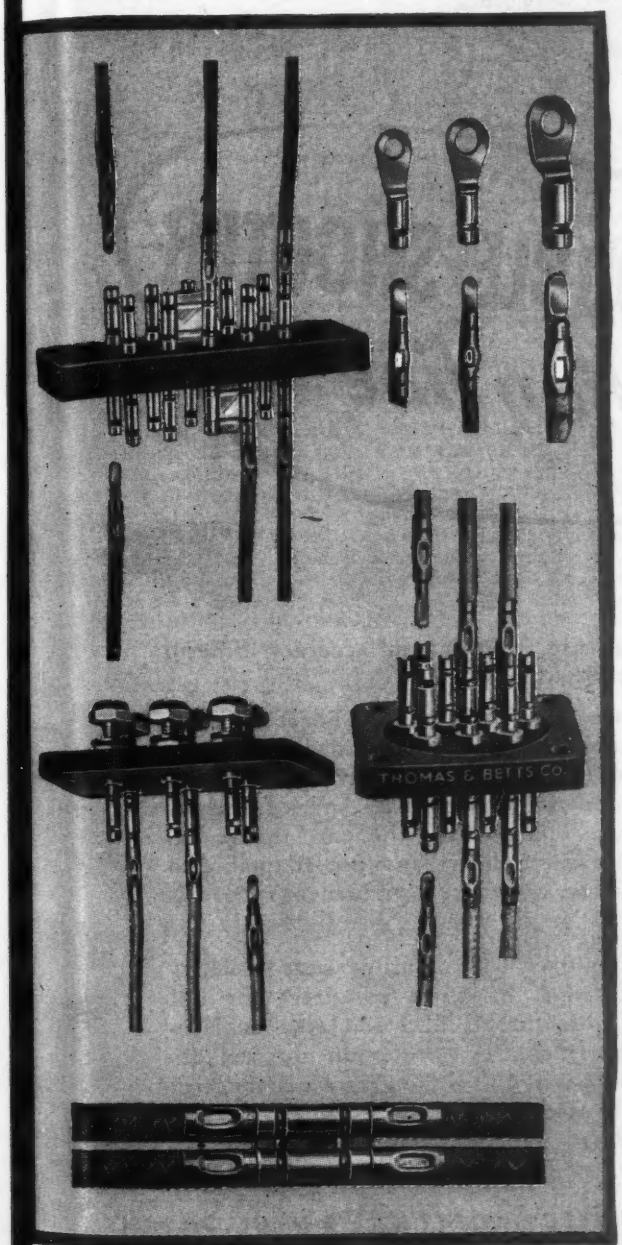
• Seems we Americans are not the only ones who sometimes have trouble with words getting mixed up in transit. A delightful Englishman told us the other day, for example, that the British have recently changed one bit of their nomenclature. Seems that once during the dark days of the African campaign Air Ministry got a frantic wire saying "send four air crews immediately." Four complete crews were dispatched forthwith, but weren't received with too much enthusiasm—for even though they were nice guys, they just couldn't be mounted on an engine to serve as airscrews.

"Mr. Maguire thought that cute little Wasp would be his honey—but did he get stung!"

T&B *STA-KON* STRAIGHT PULL



DISCONNECT* WAY OF WIRING



For Aircraft Production and Maintenance

Almost limitless combinations can be made with the T&B Straight Pull Disconnect Tips and Coupler because the tips are identical and interchangeable. A few of the possibilities are shown here.

Basically, they are wiring devices (for wire sizes #22-#10) that are readily disconnectable on straight predetermined pull, for rapid replacement and re-wiring of airplanes at maintenance depots, and for facilitating original sectionalized construction. They are designed to connect, disconnect and reconnect at will, and so act as "mechanical circuit breakers"—protection against accidental external strain. They are rounded and streamlined to the diameter of the cable to make insulating quick and easy.

T&B Approved Disconnects are members of the familiar Sta-Kon family of Pressure (solderless) Connectors, and are easily installed with standard Sta-Kon Pressure tools, manual or power.

All T&B products are distributed solely through the service organization of the Electrical Wholesaler.

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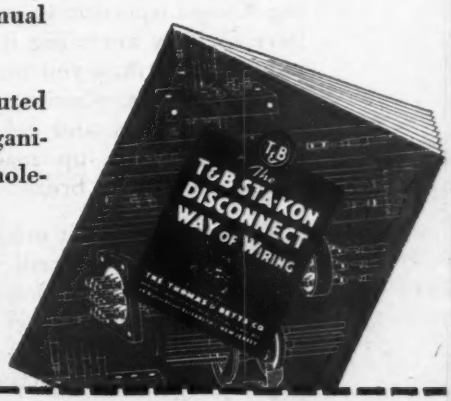

A-6

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Kindly send Catalog 522 on Straight Pull Sta-Kon Disconnect Wiring Devices.

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ARMY E NAVY

IT becomes more and more apparent that you've got to meet your competition by including X-ray inspection in your factory. For, believe us, they are using it to see with! More industrialists than you imagine are X-raying castings, welds, plastics, prefabricated metal —spotting flaws and substandard materials before they run up machining costs and before they cause breakdowns in use.

Now you can do it too, and without interrupting factory procedure, when you use KELEKET'S new inspection cabinet that hitches right onto the production line. This unit can be built to your specifications—become an integral part of your factory stream. Loading and unloading are a matter of seconds. Parts flow along on a conveyor system that speeds up, slows down, or reverses—to conform to your requirements. The whole operation is continuous . . . and inspection proceeds with an ease, rapidity, and accuracy hitherto impossible to secure.

The one unit is all you need. For it functions fluoroscopically, detecting flaws as small as 5% of the section thickness, saving film, chemical, and darkroom expense. And it functions radiographically where the parts being examined are too heavy and not adaptable to fluoroscopy, or where a permanent record is required.

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The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

Newly Strengthened Aero Chamber Posts 4-Point Program; Light Craft Future Ranged

Eased design regulations favored . . . Strength classes endorsed . . . News of air meetings . . . "Mustang" breaks transcontinental record . . . Small-airfield program wins favor . . . WTS planes on block

A reorganized Aeronautical Chamber of Commerce emerged with striking new vitality from a three-day joint session of its Directors and the National Aircraft War Production Council held in Los Angeles. And there came immediate announcement of a long-range four-point program designed to protect the United States and its aviation industry, meanwhile assuring the latter's future progress.

Authorized at the meeting was this resolution—

The United States should maintain an air power sufficient (in conjunction with other forces) not only to win this war but also to keep the peace: (1) By maintaining adequate air forces at such strength and in such state of readiness as to preclude a successful assault upon our country or its possessions; (2) by acquiring and maintaining air bases essential to our security and that of overseas trade; (3) by facilitating the orderly and economic expansion of domestic and international air transport and of private flying; and (4) by preserving a strong aircraft manufacturing industry.

Although it was stated by Eugene E. Wilson, Chairman of the Board of Executive Committee, that the "Aeronautical Chamber is an educational organization," announcement of East and West coast committees to solve "commercial" problems indicated a campaign will be waged to convert the resolution into national policy.

To Handle Peace Problems

When asked if the Chamber would use present AWPC staffs in its educational program, Chairman Wilson said the body expects to use "all tools at its disposal." This question apparently sought to probe rumors that the National AWPC would, if necessary, become the airframe manufacturers' association after the war. As indicated by Chairman Wilson, the postwar problems will be handled by the Chamber. NAWPC, meanwhile, will continue to handle war production problems.

The two committees for implementing the resolution for adoption as national policy are composed as follows: East Coast—R. E. Gillmor, chairman, Glenn L. Martin, J. Carlton Ward, Jr., Victor Emanuel, Allen Marchev, E. R. Breech, L. D. Bell, Eugene E. Wilson, and C. J. Brukner. West Coast—Harry Woodhead, chairman, J. H. Kindelberger, Robert E. Gross, Donald Douglas, T. Claude Ryan, LaMotte T. Cohu, and P. G. Johnson. First duties are seen as advice to Congress on pending legislation dealing with termination of war contracts, with disposition of government-owned aircraft plants and equipment in private plants, and with a program for the release of surplus military aircraft for conversion to civilian use.

First day of the sessions saw the following National AWPC officers named: President, Victor Emanuel; Vice President, J. H. Kindelberger; Directors, Donald Douglas, P. G. Johnson, L. C. Goad, and Alfred Marchev. Then later meetings considered such problems as manpower, employment after the war, and also the current "strategic" and "production" schedules on planes, it being noted that the curve of planes needed for specific operations and the curve of aircraft availability had come together for the first time.

The chamber, at this writing, is considering several experienced executives for appointment to the important post of general manager. This official will face difficult and continuous problems.

Industry leaders sparked revitalization of Aeronautical Chamber of Commerce. Among them were (standing, left to right,) Alfred Marchev (Republic), J. Carlton Ward, Jr. (Fairchild), Glenn L. Martin (Martin), T. Claude Ryan (Ryan), Lawrence D. Bell (Bell), Robert E. Gross (Lockheed), Eugene E. Wilson (United Aircraft), and Ernest R. Breech (Bendix). Seen seated at table are: J. H. Kindelberger (North American), P. G. Johnson (Boeing), L. C. Goad (Eastern Aircraft of GM) Harry Woodhead (Consolidated Vultee), LaMotte T. Cohu (Northrop), and Guy W. Vaughan (Curtiss-Wright).

Coming Up

June 5-7: Society of Automotive Engineers National War Material Meeting, Book-Cadillac Hotel, Detroit.

July 10-12: American Association of Airport Executives Meeting, Hotel Sherman, Chicago.

July 17-18: Air Traffic Conference, Denver.

August 2-3: National Aeronautic Association Business Meeting, Denver.

October 5-7: Society of Automotive Engineers National Aircraft Engineering & Production Meeting, Engineering Display, Hotel Biltmore, Los Angeles, Calif.

November 15-18: Second annual Clinic of Domestic Aviation Planning, Oklahoma City, Okla.

December 4-6: Society of Automotive Engineers National Air Cargo Meeting, Hotel Knickerbocker, Chicago, Ill.

January 8-12: Society of Automotive Engineers Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit, Mich.

Light Aircraft Future Projected at Detroit

Aircraft manufacturers, at their recent National Light Aircraft Meeting sponsored by the Institute of the Aeronautical Sciences in Detroit, discussed plans for a new era of personal flying after the war, indicating: (1) that the utility of light airplanes must be improved in every way possible; (2) that first-cost and cost of maintenance and fuel must be brought down; (3) that the small airfield program—to put fields at popular places where people gather—is necessary for the development of light plane travel and transportation; (4) that the government certification of pilots and airplanes must be simplified; (5) that avigation instruments and radio must be simplified and reduced in cost; (6) that the postwar market for light air-

planes will be much larger than recent conservative estimates; (7) that safety must be still further improved, even though fear is no longer a major obstacle in the way of airplane ownership.

Warner Favors Easing Of Design Regulations

With a record attendance of some 400 light plane men, 22 technical papers were read and discussed. Collating the trends expressed, Dr. Edward P. Warner, CAB vice chairman, urged relaxation of governmental regulation affecting design and construction of private aircraft.

Prime purpose of airworthiness regulations, he said, were fourfold: First, to insure uniform quality to enable the user to count on the craft's measuring up to standards of performance for the type; second, to insure that planes have no features—either of inclusion or omission—which would lead to collision either on the ground or in the air; third, to develop full information on aerodynamic and structural qualities and general behavior of new types, with such information being made available for the user's guidance; and, fourth, to make sure aircraft have no characteristics which would create hazards beyond the power of the pilot's skill to overcome.

Dr. Warner, presenting his personal views, did, however, urge tightening of regulations insofar as visibility for the pilot is concerned.

Endorse Civil Plane Strength Classes

Several other outstanding meetings marked the month. Convened in St. Louis, the Airworthiness Requirements Committee of the ACCA endorsed recommendations that all civil aircraft be classified into specific categories for licensing and operational purposes, these categories to be divided into two groups—air carrier and non-air carrier. For the latter, there was tentative agreement on three strength classes: (1) Acrobatic, (2) training or utility, and (3) normal or personal transport; and for the former, the breakdown favored was: (1) air carrier passenger, (2) air carrier goods, and (3) air carrier special purpose.

Exposition and Conference Mark Texas Program

In conjunction with Texas Aviation Week, the Southwest Aircraft & Accessories Exposition, sponsored by the Dallas Chamber of Commerce Aviation Committee, attracted several score exhibitors. There followed the Third Wartime Aviation Planning Conference at College Station, with A. & M. College of Texas and *Southern Flight* as hosts to training directors, relations personnel, and representatives of airlines, schools, manufacturers, and government agencies. Hundreds came from all parts of the country to partake in the discussions.

"EDDIE" ALLEN TUNNEL

Giant 16-blade hurricane-hurling fan—it can create nearly-sonic 700 mph. winds—in new test tunnel recently dedicated as major installation of Boeing's Edmund T. Allen Memorial Aeronautical Laboratories at Seattle. Colossal blades made of spruce, are of 24-ft. dia., and will whirl at 490 rpm. top speed, while huge hub fairing is of precise conical design to eliminate air turbulance. Tunnel will play leading part in program of progress so well advanced by the late "Eddie" Allen, internationally known test pilot and scientist. Builder of tunnel was the Austin Co., while synchronous electric motor was made by Westinghouse and regulatory magnetic coupling by Dynamatic Corp.

Oklahoma and Montana Hold Meetings

Principal speaker scheduled at the one-day Southwest Civil Aviation Forum, held in Oklahoma City at press time, was Charles I. Stanton, CAA administrator. Informal discussions aimed to answer questions on Southwest aviation problems were the order of the day. Also being held as this was written was the Great Falls, Mon., "aviation clinic." This meeting was to assist regional communities and cities in preparing for postwar aviation development, especially in regard to feeder lines.

"Mustang" Flies Continent In 6 hr. 31½ Min.

Two battlefront-bound North American P-51 "Mustangs" broke the transcontinental speed record on May 11, the time for the first ship being 6 hr. 31½ min. and for the second 6 hr. 39½ min. Respective average flying speeds were 373.54 mph. and 370.2 mph. The planes, it was stated, were fully equipped craft "fresh from the NAA production lines." Extra long-range gas tanks were employed.

Both P-51's made the identical 2,464-mi. Los Angeles to New York run. However, Col. Clair Peterson, pilot who made the fastest time, carried an initially lighter gas load and made one step for re-fueling at Kansas City. Col. Jack H. Carter, clocked 8 min. slower, came through non-stop.

Small-Airfield Program Wins Wide Approval

The program for the building of small-airfields, undertaken by the Personal Plane Department of the ACCA, has approval of the light plane industry, of the Civil Aeronautics Authority, and of many publications, communities, and pilots everywhere. The small-field program does not, as yet, have any government aid; communities are merely encouraged and instructed in establishing them. Neither is there any so-called "flight-strip" program, except that already carried out by the Bureau of Public Roads, which has completed 26 strips. CAA has appropriations to build only Class 1, 2, 3, and 4 airports.

The proposed small airfields are not expected to entail a high cost for respective communities; it is believed they will employ many returning service pilots and crewmen as instructors, taxi and fixed-base operators, and possibly fly-yourself services.

Certain leaders, among them some CAA officials, decline to support the proposals for flight strips, which are presumed to be landing facilities alongside a highway. Opponents ask why anyone would want to land by a highway, until such time as roadable planes might be used in large numbers.

WTS Planes on Block

By the time you read this, over 1,000 of the WTS planes recently declared surplus will have been sold to bidders. During the summer probably the entire 5,000 owned by Defense Plant Corporation and lent to WTS, will be offered.

Some manufacturers have complained that this sale is depleting their prospective postwar market. Government's answer is that taxpayers' would complain still louder if their money is not salvaged insofar as possible.

★ SPOT CHECKING ★

A high mark of month was great candidness with which Materiel Command, Wright Field, took members of Aviation Writers Assn. into its confidence on current striking aircraft developments and the even more striking developments which are to come.

Writers came away amazed at our present and future skyfighting power revealed in terms of warplanes, guns, rocket weapons, engines both jet and reciprocating, bomb sights, radio location devices, and 101 other things, all sparked by new speeds, climbs, and ceilings. It can be stated that they saw Bell's jet plane fly, also the Sikorsky helicopter, were given various radio-location demonstrations, looked through Norden and Sperry bomb sights, watched tests of a new wing and engine in the huge wind tunnel, and viewed Boeing's "Superfortress," Northrop's new "Black Widow," Douglas' new light bomber, and various other experimental craft.

Following their Patterson and Wright Field visits, AWA members were flown to Dallas, Tex., in First Trooper Carrier Command C-47's, visited North American and Convair plants at Fort Worth, proceeded to College Station, Tex., for their annual convention in conjunction with the Texas Planning Conference, and finally were flown, in Navy "Catalinas", to Corpus Christi for a tour of the Navy base. AWA elections: George Haddaway, president; Maurice Roddy and Philip Andrews, vice-presidents; Leslie Spencer, treasurer; Devon Francis, executive secretary; and Retiring Pres. Wayne Parrish, governor-at-large.

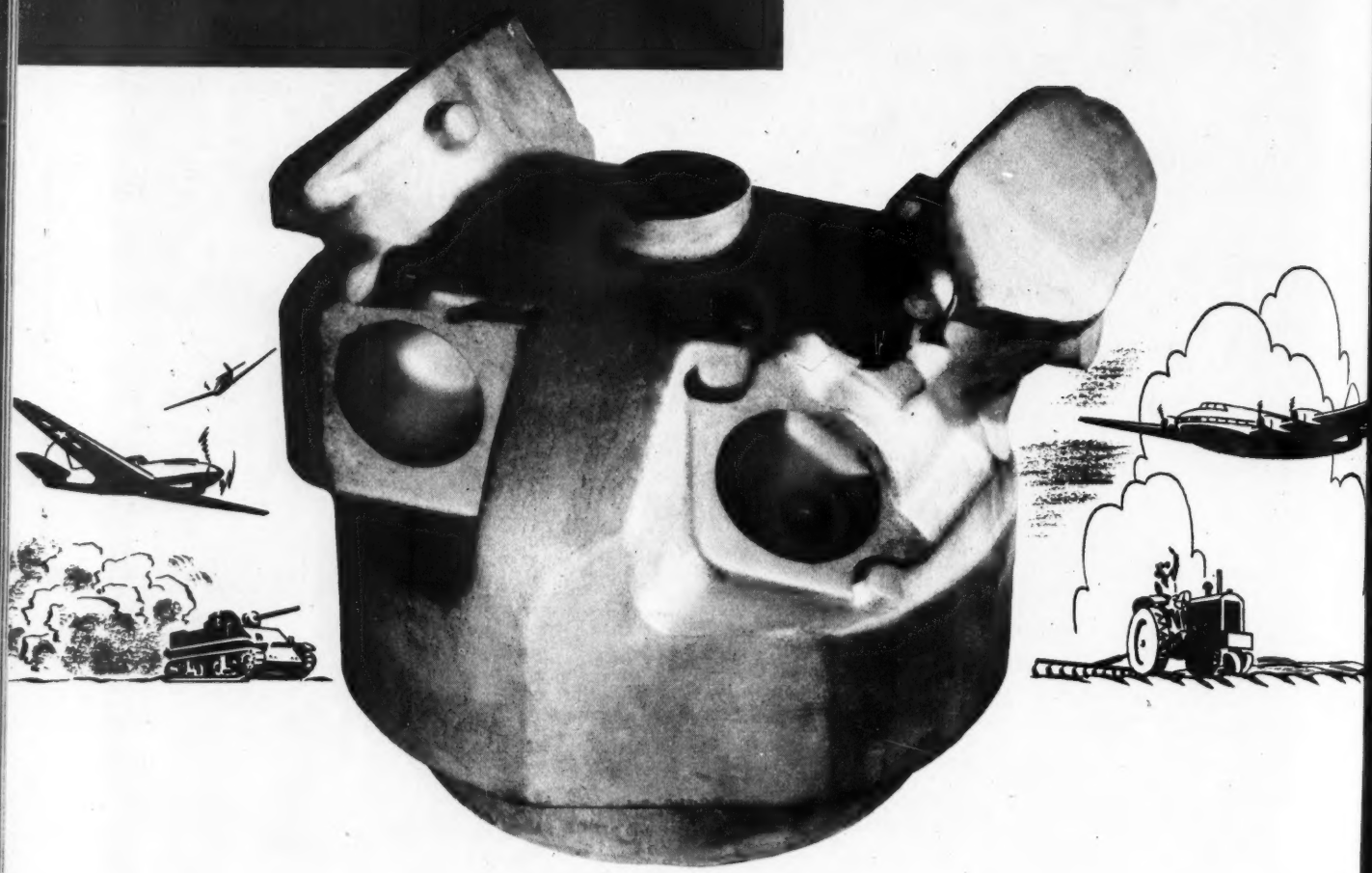
Torpedo Squadron 8

BY JAMES M. SESSIONS

NO. 6 OF A SERIES "HIGHLIGHTS OF WORLD WAR II" PRESENTED BY TUBE TURNS (INC.) LOUISVILLE, KY. SEE OTHER SIDE

Challenge

to peacetime "can'ts"

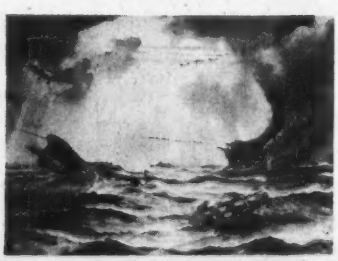


A forging as large and complex as this one requires the largest upsetter ever made.

The trend toward larger upset forgings and the use of lighter metals was recognized by Tube Turns even before Pearl Harbor. With an eye to new industrial advancements, a battery of these mammoth nine-inch upsetters was ordered; later many power presses, heat treating furnaces and special machines were added to this formidable array of forging equipment.

The pressure and exigencies of war forced the development and use of these facilities far beyond the probable need of normal industrial progress. Thus the skill accumulated during *wartime* operation will be added to the value of Tube Turns' farsighted *prewar* thinking, and the benefits will be reaped by industry when peace comes. Tube Turns, Inc., Louisville 1, Ky.

TUBE TURNS *Forgings for Industry*



Commemorating the epic sacrifice made by Torpedo Squadron 8 in the Battle of Midway (see reverse side) is Sessions' 6th in a series of 12 dramatic war paintings presented by Tube Turns.

Plan for a single unified command over land, sea, and air forces has won additional support from high offices in Washington, but concensus is that activation of such a program must await close of war.

Over the last three years more than 30,000 U. S. planes—roughly 1/5 of our production—were sent to our Allies. Lend-lease accounted for some 23,000, with remainder purchased for cash. In addition, $1,800,000,000 worth of engines and parts have been shipped, also "hundreds of millions" of gallons of aviation fuel.

Reorganization of Materiel Command's inspection division is announced, aim being speedier clearances with highest possible margin of safety of our flying equipment. Accordingly, procedures will be affected in every war plant making aviation material. Coincidentally, Col. Bryant L. Boatner was named inspection division chief.

G & A Aircraft Co., Firestone subsidiary, has presented a jump-takeoff autogiro to Princeton's aeronautical engineering department. The craft will be used as a flying laboratory for rotary wing research.

★ CALLING NAMES ★

John L. P. Brodie and **Hugh Buckingham** have been appointed directors of the deHavilland Engine Co., Ltd., in addition to the existing directors. Mr. Brodie becomes director in charge of the engineering division and Mr. Buckingham business director.

Harold J. Roig, president and director of Panagra, has been re-elected, and **Howard B. Dean,** who has been re-elected as a director, has also been made v.p. **Henry Friendly** has been chosen director in place of **George L. Rihl** and **Erwin Balluder** succeeds **E. E. Young.**

United Air Lines announces that **Homer J. Marchant,** is now acting eastern sales manager and **S. R. Newman** acting western sales manager; **Warren D. "Bill" Williams** is superintendent of western flight operations; **Harold L. Knoop,** eastern flight operations; and **Paul Reeder,** Pacific flight operations; **M. B. "Mickey" Crawford** returns as equipment engineer after serving for two years as field manager for Pesco Products; **Melvin T. Brockman** is named manager of air-truck service for the air cargo department; **S. V. Hall** is assigned as full-time manager of military operations for the ATC across Pacific. **Capt. Virgil W. Vaughan** has completed his 1,500th hr. of overseas flying for the ATC. **R. C. Wright** has been appointed assistant treasurer.

Mario Molina has joined TACA Airways Agency, as traffic representative for the N. Y. office.

Wilbert Fred Calliott was appointed general auditor for American Airlines.

Capt. C. W. "Chuck" Weibien, PCA chief pilot, has been appointed to the newly created position of System Chief Pilot. **E. E. Hartzler** has been appointed chief industrial engineer of Consolidated Vultee's Miami division, transferring from San Diego, and replacing **Quentin G. Turner,** who goes to San Diego as asst. chief industrial engineer. **Major E. A. Levinson** is now army contracting officer for the Ft. Worth division.

William P. Gwinn was elected general manager of the engine division of United Aircraft.

Wilford J. Kamerer, supt. of the Norwich, Conn., plant of Hamilton Standard Propeller division of United Aircraft, transfers to the main plant at E. Hartford as staff asst. in the office of the general superintendent; **Carl A. Krause,** plant supt. at Westerly, R. I., takes on the added duties of the Norwich plant. **Carl F. Schory,** service manager at E. Hartford, has received his 15-yr. pin. **Thomas A. Dicks** "daddy of the propellers" an engineering consultant for Hamilton Standard, recently celebrated his 85th birthday.

Charles F. Slick, formerly general factory manager, Fairchild Aircraft division at Hagerstown, has been made asst. works manager. **Louis Fahnestock** continues as works manager; **John Young** heads a new division of the production department known as production engineering. **E. L. Buchanan** heads the manufacturing division of production as general factory supt.

Orville Wright, famed aviation leader and one of the original members of the Aeronautical Chamber of Commerce when the national group was organized in 1921, has been elected to honorary life membership in the Chamber. **E. E. Wilson,** vice chairman of United Aircraft Corp., was elected chairman of the Chamber's board of governors, and **Donald W. Douglas,** president of Douglas Aircraft Co., vice chairman. Other elected officers included **James P. Murray,** v.p. Boeing Aircraft, president; **Lawrence D. Bell,** president of Bell Aircraft, and **LaMotte T. Cohu,** chairman of Northrop Aircraft, vice-presidents; **John E. P. Morgan,** treasurer, and Col. **Harrison Brand, Jr.,** secretary.

Robert G. Owens joins Zephyr Mfg. as general manager.

Frank C. Dyer, supt. of communications for Braniff at Dallas, has assumed charge of preparations for the operation of Aerovias Braniff, S.A.

Lt. Col. Robert L. Baseler has been awarded the Silver Star. While leading his group of P-47 "Thunderbolt" fighter bombers over Italy, his group destroyed 36 enemy fighters and severely damaged 6—all in 36 min.

Capt. Howard Cone, who was commander of **Dixie Clipper** on President Roosevelt's trip to and from the Casablanca Conference, recently marked the completion of 10 yr. of intercontinental flying with PAA; **Capt. William A. Winston** completed 100 crossings of the Atlantic as commanding officer of the transatlantic **Clipper; William E. "Pop" Smith,** 15 yr. veteran of Pan American intercontinent maintenance problems, was honored by a party attended by 500 fellow employees. **Robert C. Hallett** was named asst. division traffic manager of the Atlantic division, with offices at LaGuardia

THE WASHINGTON WINDSOCK

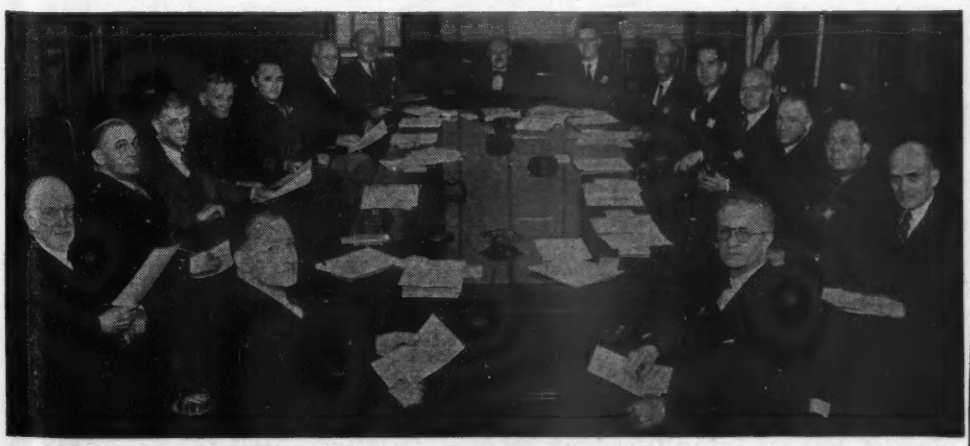
By BLAINE STUBBLEFIELD

An engineer told us that jet-powered airframes, minus the weight and vibration of rotating engines, will last two or three times the present 10-15 yr. life of conventional planes. And the jet engines themselves, with very few rotating parts, may some day last as long as the airframes—an even greater economy. When and if such durability becomes common, manufacturers will have to slope the hood a different way each year and figure out some knee-action come-ons.

Standard world-wide airworthiness regulations will be the subject of long debate. It has taken years to reach a semblance of agreement in this country alone. Nations might never agree. Even if they did, some think we would thus be helping cheap-labor countries with inferior engineering ability to compete against us.

Some experts are amazed that Germany could take so much bomb demolition so long and not show more weakness. They say that aviation has actually done almost the expected damage. At the same time, they admit that air bombs, on the average, are at low velocity on contact compared with large shells and that accordingly they are limited in penetrating power.

Prestige of CAB is on the steady upgrade because of its constant hard work and its studied impartiality. Air representatives of several foreign governments have been here taking notes on CAB organization and procedure. Authority of the Board is nevertheless threatened by world importance of aviation and the temptation of big-league politicians to take it over.



GOAL: BETTER FIGHTING PLANES

Means to improve military effectiveness of combat aircraft was topic when NACA members conferred recently with Army and Navy leaders in Washington. In foreground are William Littlewood (left) and Dr. Theodore Wright, and at table (left to right) are: Dr. William Durand, Maj. Gen. Echols, Dr. Vannevar Bush, Vice Adm. McCain, Maj. Gen. Giles, Dr. Orville Wright, Dr. George Lewis, Dr. Jerome Hunsaker, John Victory, Dr. Charles Abbot, Dr. Edward Warner, Dr. Lyman Briggs, Rear Adm. Pace, Hon. William Burden and Dr. Francis Reichelderfer. Jet propulsion was one of the subjects discussed.

NATION'S CAP WING COMMANDERS GATHER

With 47 states represented by Wing Commanders, the Civil Air Patrol closed its recent two-day meeting in New York City with this dinner at Waldorf Astoria. Host was Maj. William P. Lear, CAP Communications Director and President of Lear Avia. Among honor guests were Maj. Gen. Robert W. Harper, Deputy Chief of Staff Air Training: Lt. Col. Earle L. Johnson, CAP National Commander; and Thomas Beck, Crowell-Collier Publishing Co. chief. Gen. Harper stressed the General Staff's long-term regard for CAP, said Patrol would play an even more important role in coming peace.

Field, and he will assist division traffic manager **Phil S. Delany**; **Donald O. Q. Lampland** was named senior staff engineer at the transatlantic terminal; **Tolbert A. Rice** was named district manager for the United Kingdom and Eire, with headquarters in London; and **A. Jackson Kelly**, district traffic manager and senior representative of the airline in the British capital, now furloughed home after two years abroad, will be assigned to division headquarters at LaGuardia Field upon completion of his vacation.

Douglas Aircraft announces that **Herman O. Olsen** has been named asst. superintendent of assembly in the C-54 plant; **W. G. Jerrems** is named manager of the Tulsa, Okla. plant; **Jack A. Handley**, plant engineer of the Long Beach plant, now is in charge of maintenance and construction of the numerous "feeder" shops; **Lee J. Robinson** is appointed subdivision head for industrial and public relations at Oklahoma City; **Howard P. Maginnis**, formerly with the Tulsa, Okla., **Tribune**, becomes A. M. Rochlen's representative for the industrial and public relations departments at Tulsa; **Tom H. Brennan** is now properties manager of plant layout equipment and machinery control industrial engineering and methods at Santa Monica; **E. N. Classen, Jr.**, is now asst. superintendent of fabrication.

George F. Lewin was appointed assistant to Harry R. Brashear, manager of the traffic department of the ACC.

George P. Torrence assumed the presidency of Cleveland Pneumatic Tool and its subsidiary Cleveland Pneumatic Aerol, Inc. and concurrently, **Daniel C. Green** was elected board chairman of both companies.

Jack Frye, TWA president, was elected a fellow of the Institute of the Aeronautical Sciences. **Russell G. Petitte**, district traffic manager in St. Louis since 1938, was appointed asst. to **W. W. Coyle**, midwest traffic manager; **John D. Thomas**, N.Y., reservations manager, transfers to St. Louis to succeed Petitte, and **W. J. MacDonald, Jr.**, chief reservations control representative in N.Y., was named to Thomas' former post.

William A. Coulter, was re-elected president and chairman of the Board of Western Air Lines at the annual stockholders' meeting; **L. H. Dwerlkotte**, v.p., **Harold P. Fabian, Stanley W. Guthrie**, and **George A. Smith** were re-elected directors, and at a meeting following the stockholders session, Mr. Dwerlkotte was elected executive v.p.; **Charles N. James**, v.p. operations; **Thos. Wolfe**, v.p. traffic; **Paul E. Sullivan**, secy.-treas.; and **J. J. Taylor**, asst. secy.-treas.

Ernest G. Stout, design staff engineer for Consolidated Vultee and winner of the Lawrence Sperry Award, has been elected an associate fellow in the Institute of the Aeronautical Sciences.

I. S. Randall, past president of the Advertising Club of N. Y. and past president of the Sales Executives Club of N. Y., has joined Bressler Editorial Cartoons as v. p. and sales manager.

AMERICA AT WAR

Aviation's Communique No. 30.

Continuous and steadily mounting air attacks through late spring in preparation for the actual land invasion meant that the Allies had finally built up their long-sought air power margin. Magnitude of the production phase of this task, already accomplished, is implied in the Army-Navy production program for the rest of this year, in which 36 percent of the total is aircraft.

In Sept. 1940, the Luftwaffe loosed nearly 10,000 tons of bombs on England. Never again did it reach that rate of delivery. In the one month of Apr. 1944, British and American air forces dropped nearly 100,000 tons of incendiaries and explosives on Hitler's targets. This is more than Goering's total of missiles unloaded on England in this war to date.

About 45,000 tons of the April deliveries on Europe were by American forces based in England and Italy. American losses were 537 bombers, less than 3 percent of participants, and 191 fighters, just above 1 percent.

The power of both RAF and AAF is such that each can send out forces of 1,000 heavies day after day, American daylight attacks being supported by about 1,000 fighters. Greater forces are feasible on occasion. In two days, the AAF sent 4,000 bombing sorties over Europe and shot down 112 Nazi planes in the bargain. Largest RAF force, according to press reports, was 1,100 heavies up to this writing. In one recent 30-hr. period, 6,500 Allied planes unloaded bombs on Nazi-held Europe.

American planes used in greatest numbers against the Germans are the Boeing B-17 *Flying Fortress*, the Consolidated B-24 *Liberator*, Republic P-47 *Thunderbolt*, North American P-51 *Mustang*, Lockheed P-38 *Lightning*, and the Martin B-26 *Marauder*, this latter reported attacking in "swarms." The British de Havilland *Mosquito*, depending on speed for defense, seems to be an institution in itself.

In the Pacific, the Navy's sphere of air control is expanding from captured islands and new air bases, closer and closer to Japan. Naval forces, with carriers so numerous that twelve of them recently showed in a picture of one harbor, are so great that the Jap fleet has been entirely withdrawn.

As the Japs back closer to their home grounds their supply lines shorten, to their advantage. The Allies, with vastly greater strength, are following them in to practical bombing bases. Some day the air attack will begin from the Kurile Islands (which Secretary Knox said, a few days before he died, that we would take) from islands southward, from the shores of China, or from our carriers—or all four. But Japan is moving war production into Korea and Manchuria, and war commanders are preparing for land action in the Orient, as in Europe.

Consolidated *Liberators* recently flew a 2,000-mi. round trip to an effective attac'- on an island called Satawan; such trips are rapidly becoming commonplace. Adding to the Jap's woes, the Navy is using new rocket throwers. And a new version of the Grumman F4F, the FM-2 built by Eastern Aircraft, has more power, less weight, more speed, and improved performance.

The impressive showing made by airpower in this war, though it has not met the expectations of optimists, has finally won enough converts so that the Congressional Woodrum Committee on Postwar Military Policy is giving most of its attention to the air phase of national defense. This committee will blueprint the size of military forces to be maintained in peacetime, depending upon the kind and extent of peace.

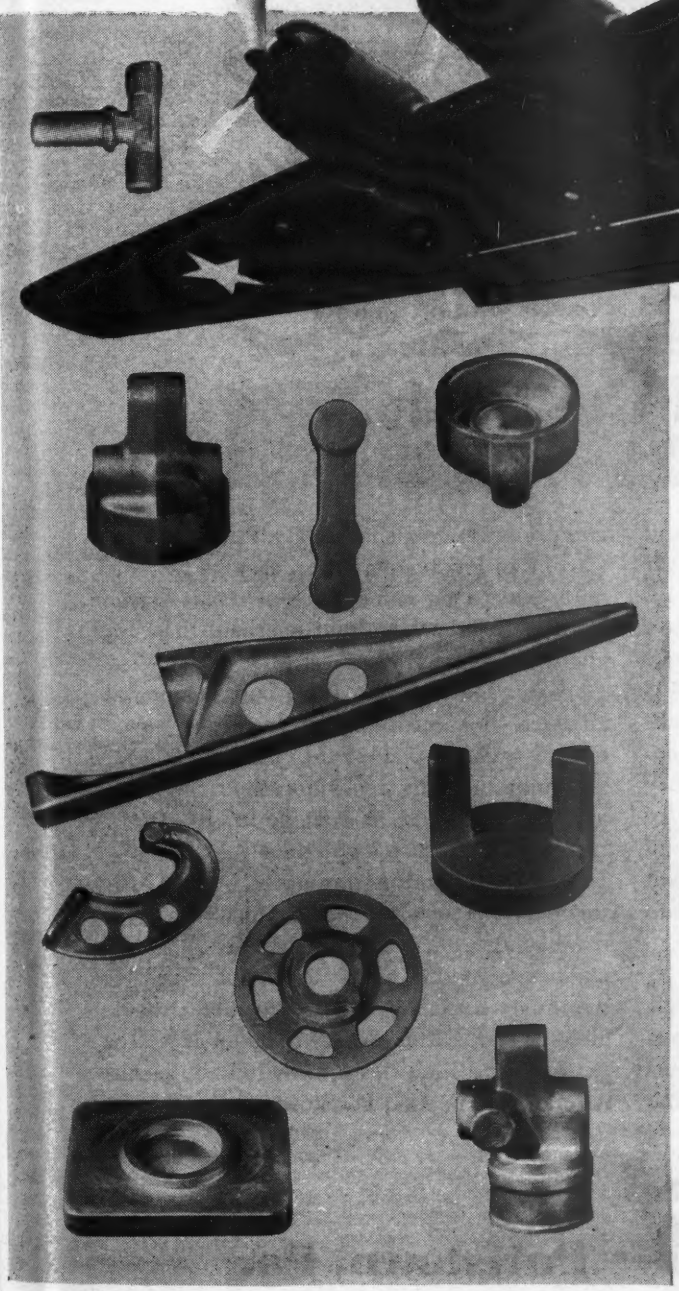
Obituary

Mrs. Florence Shloss Guggenheim, widow of late Daniel Guggenheim, who established Daniel Guggenheim School of Aeronautics at New York University and Daniel Guggenheim Fund for promotion of aeronautics. In turn, Fund endowed schools of aeronautics or professorships at Massachusetts Institute of Technology, Georgia School of Technology, California Institute of Technology, University of Washington, Leland Stanford, Syracuse University, and University of Michigan, also donated $250,000 for establishment of Airship Institute at Akron. In 1942, as a memorial to her husband, Mrs. Guggenheim made a gift of her Port Washington, L. I., estate for establishment of a center for aeronautical research and study to be undertaken through the Institute of the Aeronautical Sciences.

A. Leo Stevens, pioneer credited with numerous parachute developments and early lighter-than-air man. He made more than 3,400 balloon ascensions, and a dirigible built by him made its first successful flight in 1902. A member of various balloon clubs and an honorary member of the Aeronautical Society of America, he was working with the Switlik Parachute Co. at the time of his death.

William Thomas Miller, chief of Air Carrier Div., CAA, since 1938. Previously, he had served as a lieutenant commander in Navy and was credited with making an aerial survey of South Pacific for Navy from 1935 to 1937.

Aluminum Die-pressed Forgings by REVERE



HERE are shown only a few of a great variety of strong, close-grained airframe and engine parts and fittings, as die-pressed of aluminum by Revere. Note not only the simpler designs, but also the larger and more complicated ones. In fact, Revere, a pioneer in this field, has successfully forged shapes and sizes once considered too difficult to produce.

Revere forgings are produced in magnesium, copper, brass and other copper-base alloys in addition to aluminum. Technical advice, without obligation, is gladly given by Revere on problems you encounter in the non-ferrous forging field. Write Revere Executive Offices.

★

MANUAL. Ask for your complimentary copy of the 54-page manual, "Revere Copper and Copper Alloys—Technical Information for Product Designers." Contains 106 graphs relating to the physical and metallographic properties of these alloys under varying conditions, a new chemical and physical properties chart, and valuable illustrated information on welding techniques. Sent on request.

REVERE

COPPER AND BRASS INCORPORATED

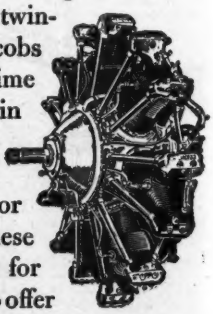
Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N.Y.

The combat plane is cherished by ground crews. The transport travels between repair shops. The private flier hugs his home field . . . But for years up in the Canadian wildernesses clear to the Arctic circle, the bush pilots broke all the rules. They packed freight and passengers over uncharted woods and waters to flyspecks on the map, flew through fog, rain and sub-zero cold without benefit of beam or beacon. They sideslipped into cubbyhole clearings, flopped their floats down on lost lakes, sat down and took off in deep snow . . . And if anything went wrong with plane or power plant, the pilot relied on a tool kit, and his own wits and skill.

LONG before the war, bush pilots put their money on Jacobs, knew the engine didn't have to be babied, stood up day after day for months on jobs that taxed the resources of both plane and pilot, were dependable at all times . . . easy starting in low temperatures, easy on fuel and parts, easy to get at for check or repair, stayed on the job longer without overhaul than any engine in its rated class.

When the war came, the Jacobs engine was an asset—not an experiment. In twin-engine training planes, the Jacobs takes more take-offs, works more time at full throttle than any engine in combat service, stands up under hard student handling for more than 1,000 hours between major overhauls!...The war record of these engines is another good reason for watching what Jacobs will have to offer after the war . . . when costs will count as well as performance. Inquiries are invited . . . Jacobs Aircraft Engine Co., Pottstown, Pennsylvania.



JACOBS · Pottstown, Pa.

Senate Committee Okays Bill on Contract Settlements; 8,343 Planes Made in April

Postwar designing gets APB "go ahead" . . . Buick tools for new P. & W.'s . . . Boeing reports greatest year . . . K. C. plant turning out high-power P. & W.'s . . . Surplus War Property body in action

Senate Military Affairs Committee recently approved a bill providing for creation of an independent office of contract settlement which would be headed by a director to be appointed by the President. Subcontractors would be included in prime contra-tors' claims for settlements. Contractors would be financed within 30 days after they file application, pending settlement. Government would be required to move its machinery out of private plants within a period of 60 days.

Court of Claims would be final arbiter, and authority of the General Accounting Office would be limited to cases of fraud.

April Output 8,343 Planes, 96 Million Pounds

Aircraft production dropped back to 8,343 planes in April, somewhat below the output of 8,362 in Oct. 1943. Production in poundage also fell off 6 percent (from the 103.4 million-pound record set in March) to 96 million. C. E. Wilson, chairman of the Aircraft Production Board, explaining the decline, said April had only 25 working days, but mainly it was due to increasing emphasis on needed combat types, which constituted 77 percent of the total in April, a new high.

Wilson stated the industry is doing a good job but the continued shift to longer-range types and constant improvements based on battle experience will call for continued maximum effort. West Coast AWPC calls attention to constantly increasing speed, higher ceilings, and better armament, all of which takes more hours of work.

Postwar Designing Gets APB "Go Ahead"

Dr. A. E. Lombard, speaking for the WPB Aircraft Production Board, told the industry recently that it is free to go ahead with development of postwar aircraft and any other product designs. Lombard said this relaxation is possible because the industry has hit its peak output. He cited WPB Order No. P-43, of Mar. 6, permitting laboratories to obtain materials and build prototype articles for manufacture after the war.

Buick Tools for New P-W's

GM's Buick Div. is tooling to make two additional types of P. & W. engines for Consolidated B-25's and Douglas C-54's. Both are twin-row *Wasps*, R-1830-75 and R-2000-9, of different dimensions and developing greater horsepower than current types. Buick has an AAF contract for engines totaling more than $60,000,000. Stand-in machinery is being placed in the plants for production of the new power plants while present equipment continues turning out current types for B-24's and Douglas C-47's.

Boeing Reports "Greatest Year of Achievement"

In Boeing's annual report, Pres. P. G. Johnson refers to 1943 as Boeing's "greatest year of achievement." He says requirements of the Army Air Forces for both B-17's and *Kaydet* trainers have been met. Production deliveries of the B-29 *Superfortress* has begun in two of the company's divisions at Wichita and at Renton, Wash. The Seattle Div. now goes into process of conversion to B-29 production. This conversion will be accomplished gradually, with B-17 production decelerating while B-29 production is being accelerated. Mr. Johnson says 10,000 *Kaydets* have been built. He concludes that problems greater than those encountered in the war must be faced after the war, and that it may be necessary for the company to manufacture and market other products in addition to aircraft.

K. C. Plant Turning Out High-Power P. & W.

Pratt & Whitney's new engine plant at Kansas City is turning out the new R-2800-C engine officially rated at more than 2,100 hp. The plant, specifically designed and tooled to produce this particular engine, has a capacity of 3,000,000 h.p. per month. About half of the ultimate work force of 29,000 have been employed. Of the 1600 parts that go into the R-2800-C, more than 600 are made at the K.C. plant. The plant is sponsored by the Navy, which does not, however, have exclusive right to its output. It is government-financed and the P. & W. management has made an unprecedented agreement with the Navy to operate it without any remuneration.

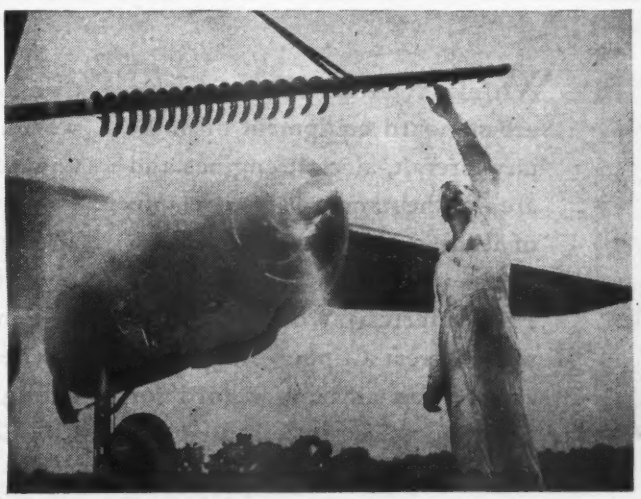
Surplus War Property Body in Action

A Surplus War Property Administration has been set up in Washington, and by the time you read this it will have issued Order No. 1. A subcommittee had been formed at this writing to deal with SWPA's most difficult problem—that of disposal of surplus airplanes and of surplus airfields. CAA Chairman W. Pogue is a member of the Surplus War Property Board.

Disposal of surplus warplanes will have an important effect on the aircraft industry. It is expected that the government will hold many planes to maintain strength of postwar airforces, keep many as standby's, and otherwise avoid dumping enough of them on the market to seriously hurt the merchandising of new production. It is believed that only the transport planes, the light liaison planes, and perhaps a few trainers, will have any commercial value.

"Merlins" En Masse

A record breaking first-quarter production of Rolls-Royce *Merlin* aircraft engines (which power the North American P-51) is reported by Packard, which meanwhile notes that engineering changes on this two-stage two-speed supercharger engine, dictated by battlefront experience, have averaged 400 per month since production started. The company recalls that some manufacturers once considered the engine too complicated for volume consumption.



ICES BLADES—BUT FAST!

Air engineers of Propeller Div. Curtiss-Wright, Caldwell, N. J., working in cooperation with AAF Materiel Command, use this novel spray outrigger to spew water on bomber props during flight in order to make precise de-icing and anti-icing tests. Outrigger draws water from 400-gal. tank fitted in bomb bay. At high altitudes, spray ices on airscrews, then de-icing solution currently under study is tried out on surfaces of blades.

★ PLANE LINES ★

Convair's projected six-engine mid-wing monoplane, the mammoth Model 37 transport for postwar, was recently shown in initial full-scale wooden mockup form to members of the Aviation Writers Assn. visiting the Fort Worth plant. Features: Capacious double deck to carry as many as 400 passengers, huge flaps and reversible pitch props to brake landing speed, de-icing of "hot-wing" type via piping. Fabrication with a new type alloy is planned. Certain of the components were reported already being turned out, with some 16 major and 400 minor manufacturers seen contributing to the project. Gargantuan size of mockup amazed observers, led one to remark, "It's like a flying Holland Tunnel."

Meantime, reports came from Coast of first test flight of Convair's Model 39, postwar 48-passenger airliner (see page 215 May AVIATION for details of this plane).

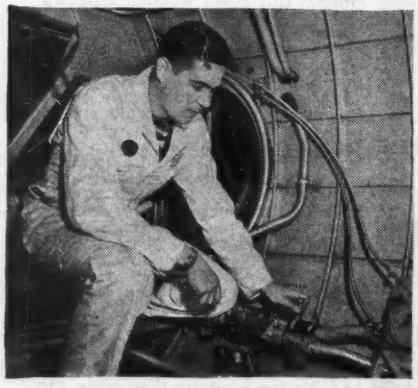
Public got word of two new helicopters—two-place Bell and craft developed by Aeronautical Products. Bell ship employs two-blade 33-ft.-dia rotor and it is powered by vertically-mounted 160-hp. horizontally opposed Franklin aircooled engine. A stabilizing device is stated to render rotor independent (of mast) so that it

Pan American Clippers Use

WITTEK

AVIATION HOSE CLAMPS

Pan American World Airways mechanic adjusting Wittek Hose Clamp in nacelle of Clipper Ship.



Wittek Aviation Hose Clamps are standard equipment on military aircraft, aircraft engines and are also the standard service clamp of leading Commercial Airlines. Outstanding among this group is Pan American World Airways whose great Clipper Ships have amassed an amazing record for *Safe Air Miles* in essential air transportation throughout the world. Wittek Hose Clamps have flown each of these safe miles with Pan American. The performance and dependability of Wittek Aviation Hose Clamps is recognized by Pan American World Airways —where only the best is good enough. Wittek Manufacturing Co., Chicago 23, Illinois.

War Bonds for Victory—

ARMY E NAVY

Buy MORE in '44!

WITTEK *Aviation* HOSE CLAMPS *Since 1923* WMCo.

tends to retain a horizontal plane.

AP's first 'copter employs a three-blade 30-ft.-span rotor geared to a 115-hp. aircooled engine which is mounted in craft's nose in conventional tractor style, but later models will have power plant within cabin.

Development is also announced of two new larger-size Sikorsky helicopters reported planned for production this year. Company is known to be working on a 14-place craft.

Latest version of Douglas A-20 "Havoc" is stated to have double the fire power of earlier models, with nine .50-cal. guns mounted.

New highly armed North American B-25 is described as a "minimum altitude strafer and anti-personnel fragmentation bomber." It packs fourteen .50-cal. m.g.'s plus a 75-mm. cannon. This is model carrying brace of "package guns" on either side of cockpit.

Also publicized during month was new Grumman FM-2 "Wildcat," being produced by Eastern Aircraft Div. of GM at Linden, N. J. Features: Faster climb than original "Wildcat," shorter takeoff and lower landing speed, less weight despite use of a greater-horsepower Wright engine (forged cylinder-head plant).

Republic "Thunderbolts" are now being delivered to Russia under lend-lease.

★ ASSEMBLY LINES ★

A Boeing "Flying Fortress" has established what is believed to be a new AAF service record flying 330 hr. 20 min. in a single month.

Kelley-Koett airframe parts maker, operating two plants, has increased production more than one-third in 1943 compared to 1942.

Chance Vought Aircraft Div. of United completed construction of its 3,000th F4U-1 "Corsair" fighter plane.

United Nations are now producing 400,000 barrels of 100-octane gas per day.

First-quarter poundage output of the Pacific Coast AWPC aircraft plants, excluding spares, was 60.7 ahead of the same period last year and exceeded the first three months of 1941 by 1,337 percent. April airframe poundage was 30.9 million, comparing with 36 million in the March peak and 24.4 million in April of '43.

Goodyear Aircraft Corp. will make tail surfaces for Army P-38 "Lightning" fighters.

Hamilton Standard has been awarded a certificate of merit by the insurance companies for its low mark of 7.3 lost-time accidents per million man-hours.

Allison has completed its 50,000 engine, raising total hp. produced to 60,000,000.

Sixty key employees of The Austin Co. have been cited by the Navy for meritorious civilian service.

At Seattle on May 12, the 5,000th Boeing "Flying Fortress" came off the line. Meantime, as B-29 work proceeds, special trucks have been built to haul the larger "Superfortress" assemblies from the Seattle plant to Renton, a special dispensation having been obtained from the state to run the big trailers over the highways.

Cleveland Pneumatic Tool Co., landing gear maker, celebrates its 50th anniversary this month.

Revised bulletin ANC-19, "Wood Aircraft Inspection and Fabrication," will shortly be available from the Government Printing Office.

Removal is announced of the old 600-lb. quarterly limit on the use of new aluminum in the manufacture of new patterns, according to a WPB release.

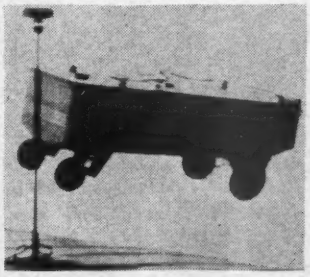
Glenn L. Martin's engineering department has developed a new droppable sponson fuel tank for increasing range of PBM-3 "Mariner" by 60 percent with no appreciable effect on performance characteristics other than a 2 percent reduction in top speed. Designed by John D. Pierson, it is reported to overcome limiting factor of former auxiliary gasoline tanks by providing added planing area to compensate for the additional fuel weight.

A new aircraft starter that cranks 2,000 hp. aircraft engines, yet weighs only 32 lb., is reported by Philadelphia Div. of Bendix. Fly-wheel of starter weighs only 5 lb., but spun by an electric motor to a speed of 28,000 rpm., it delivers a punch of more than 1,200 ft./lb. Flywheel can also be cranked by hand should battery power fail or in event there are no facilities for battery charging. The starter is already in use on the fighting fronts.

Ranger of Fairchild has obtained three new war contracts for material for combat planes through AAF Materiel Command. Contracts, made with Packard Motor Car, Continental Motors, and Andover Motors, will make necessary a three-fold increase in personnel.

A research project to obtain fundamental data on high speed milling has been established at California Institute of Technology under contract with WPB, through Office of Production Research & Development. Project was recommended by AWPC and by Manufacturing Engineering Committee of ASME.

Successful flight tests of an Army basic training plane equipped with a glass-reinforced plastic fuselage, sides, panels, and tail cone, have been made, following a research program initated by AAF Materiel Command to develop high-strength plastic structural materials for aircraft construction use.



THAR SHE FLIES!

A steel tank on wheels, "Flying Flossie," as she's called, is rated as a key piece of aero equipment aboard British battleships. Specifically, the Royal Navy uses her to test the trim and punch of aircraft catapults. Nominated for a ride in "Flossie": Herr A. Hitler. (International News Photo.)

PRODUCTION-BATTLE CITATIONS

★ **Four Stars** ★

LODGE & SHIPLEY MACHINE TOOL CO.
ELECTRIC STORAGE BATTERY CO.

★ **Two Stars** ★

MACK TRUCKS (3 plants)
I. F. LAUCKS
THE THOMAS & BETTS CO.
VICTOR EQUIPMENT CO.
SPRAGUE ELECTRIC CO.
ARO EQUIPMENT CORP. (Bryan, Ohio, plant)
ALUMINUM INDUSTRIES

★ **One Star** ★

CHAMPION SPARK PLUG CO.
ARO EQUIPMENT CORP. (Cleveland, plant)
BRIGGS CLARIFIER CO.
WESTINGHOUSE ELEC. & MFG. CO. (4 plants)

Army-Navy "E"

CINCINNATI INDUSTRIES
WESTERN AUTOMATIC MACHINE SCREW CO.
POSEY MFG. CO.
LANGLEY CORP.
SUPERIOR TUBE CO.
SCINTILLA MAGNETO DIV., BENDIX AVIATION CORP.
LINK-BELT CO. (Pacific Division)
CLARKE AERO HYDRAULICS

★ FOR THE RECORD ★

Sprague Specialties Co. has changed its name to Sprague Electric Co.

Thermex Div., Girdler Corp. Louisville, announces opening of a New York office, with Hugh Cameron as eastern representative.

The Bristol Co., Waterbury, Conn., announces opening of a new Cleveland office.

Douglas Aircraft Co.'s Chicago plant will have three new cafeterias, approximately $500,000 having been approved for immediate construction.

Glenn L. Martin's new flying boat hangar, capable of holding 3 JRM "Mars" or 6 PBM "Mariner" flying boats, is nearing completion at new Strawberry Point seaplane base. Hangar is of permanent steel construction with 200 ft. clear doors at either end. A two story structure at one side will be used for office and storage space.

Felt Products Mfg. has acquired another new factory building in Chicago.

Jacobs Aircraft Engine Co. at Pottstown has constructed a new windowless 11-acre plant.

National Aviation Supply Co., just formed in Pittsburgh, Pa., will carry a large stock of aviation supplies and equipment. Immediate propeller reconditioning services are offered.

The Aircraft Electrical Council, a subdivision of the National Electrical Mfrs. Assn., has been formed to provide more effective contact between aircraft and electrical manufacturing industries.

The Norden Laboratories Corp. has been formed, with Carl Norden as president and with Theodore H. Barth, president of Carl L. Norden, Inc., as v.p. and treasurer. This new research and development organization will headquarter in New York City.

Yale & Towne Mfg. Co., New York City, has purchased the scale business of the Kron Co., Bridgeport, Conn.

Midwest Aircraft Sales Corp., light plane distributor, has retained Aviation Associates, Chicago, to make a detailed market analysis of the area which it will serve.

Goodyear Tire & Rubber Co. has created a plastics and chemical sales division. It will be headed by Herman R. Thies.

Ballard Aircraft recently opened a new service office at Atlanta, Ga., to provide quick response on service calls.

Southeastern Air Service, Inc., is new name of Georgia Air Service.

★ KNOW-HOWS ★

Douglas Aircraft's El Segundo supervisor, S. H. Phillips, has developed a light-weight compressed-air-expanded type plastic rivet for joining plastics together with sheet metal. In addition to weight saving, it is stated to afford new man-hour economy, also optional coloring to match material being riveted.

Glenn L. Martin's new "Flight Floor", a sprayable Thiokol-ground cork floor compound resistant to fire and usual corrosives, is being used extensively on **Mariners, Marauders,** and **Baltimores** instead of rubber matting, with a saving of over 180 grams/sq.ft. in weight as applied. It is reported very little wear was shown by the samples exposed to passage of more than 100,000 people, also that this floor finish does not become slippery when wet.

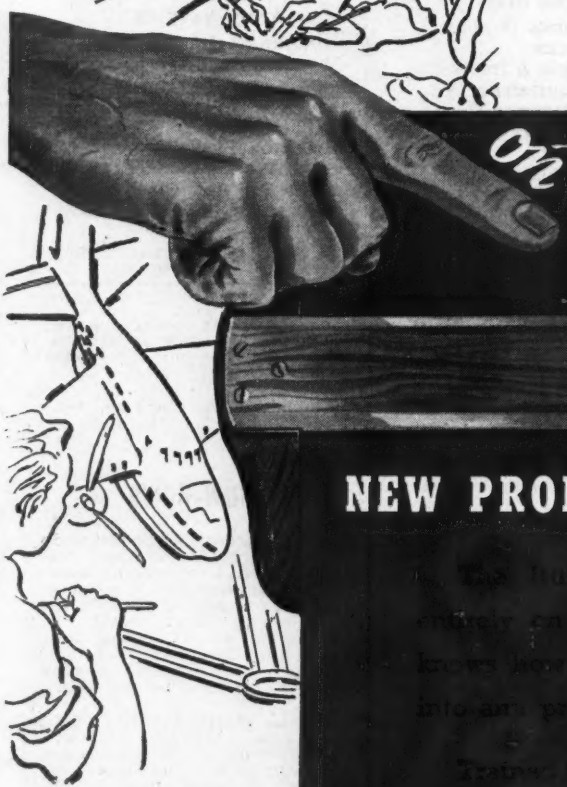
The same firm reports development of a mechanical draftsman for the trimetric projection process, giving three-dimensional drawings with a minimum of perspective distortion at a cost permitting use for shop or advertising work. The new device, known as the Martin Axonograph, combines, with a camera, the necessary electrical and mechanical movements for creating shop illustrations under the system.

Chips, which formerly required one man's full time at Martin's to remove from milling machines, are now blown clear as made, the process being performed by twin air jets delivering into a box beside the machine. Additional advantage is automatic scrap separation at source, abolishing former time-wasting separation after all waste metal was collected.

Robert A. Weaver, of New York, announces development of a new porcelain enamel, tough, light, and highly heat-resistant, which may be used as an exhaust stack finish to add to engine efficiency by reducing exhaust drag.

Bendix reports a plastic substitute for human hair in weather instruments, developed by Friez Instrument Div. An electric hygrometer strip, it is now being used in ray sondes.

NEED ANY HELP...



on DESIGNING

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Prospects Better for Return of Planes To Airlines; Air Law Battle Slacks Off

Notes on international transport meetings . . . Matson still presses for Hawaii service . . . International group plans Atlantic operations . . . Traffic in broad gain . . . Route applications . . . Re gas rationing

With good chances of getting back most or all of their requisitioned airplanes and with their pilot situation improved by termination of the CAA-War Training Service, many air transport leaders find things in better shape now and, furthermore, see improved prospects for the future.

Army is negotiating with the airlines for return of about 24 more planes this spring. That will leave in possession of the Army 100 more, which observers believe will be back in private service before the end of autumn. Many of the planes—mostly Douglas DC-3's and some Boeing 247's and Lockheed 10's—were purchased outright by the Army, while some were leased. Establishment of a price basis for sale back to the airlines may serve as a precedent for terms under which war surplus transport planes will later be disposed.

Air Law Battle Slackens; Big Fight Postponed

So complete was the failure during recent months of efforts to revise the civil air law that the battle now is behind the scenes. Railroads and ship lines are maneuvering for the big fight when it does come, probably not this year. Department of Justice, Civil Aeronautics Board, and many congressmen are against joint management of air and ground services. Canada's new Air Transport Board is being set up with machinery to break down the domination of airlines by the railroads in that country. In England the question of steamship participation in aviation is still an open one. Both the Lea bill and the newer McCarran bill appear to be dormant on Capitol Hill.

Notes on International Transport Meetings

Though new American-flag foreign services will carry but small traffic compared with domestic system loads, the airline managements anxiously await decisions that will determine their off-shore futures. The governments of the United States and Britain, by far the biggest world operators, continued their meetings in England and in Canada toward laying the foundation of a world plan. Lord Beaverbrook, Under Secretary of State Adolf Berle, and E. P. Warner, vice chairman of CAB, reached preliminary understanding as to the degree of control government should exercise over international operations, leaving the mechanics of control for future study. They agreed that subsidies should not be used competitively but only to keep in operation non-paying routes of national importance. It was taken for granted that Germany and Japan should not be allowed to own and operate air transport services for a long time.

At this writing, representatives of the Russian government were awaited for a conference in Washington. Competent opinion in the Capital is that the full-dress United Nations conference cannot be held this year. Mr. Berle and other officials have said the question of sovereignty over lend-lease air bases after the war is of little importance. Meanwhile the airlines are awaiting information as to what terms will be set up for the termination of their Transport Command contracts. (Also see "Abroad" news story, page 225.)

Matson Co. Still Presses For Hawaii Service

Matson Navigation Co. recently reiterated its determination to operate air services from West Coast cities to Hawaii, for which application was filed last September. Matson takes the position that the civil aeronautics law does not forbid air service in conjunction with its steamship service, or if it does, then the law should be changed. In 1935, say company officials, Matson invested $500,000 in Pan American stock, the money to be used toward financing facilities and equipment for the U.S.-Hawaii air service. CAB overruled the agreement, which included also the use by PAA of Matson terminal facilities and meteorological information. Matson is reported to have sold most of the stock.

International Group Plans Atlantic Operations

"Important interests in Canada, United States, and Great Britain" will join with a Newfoundland group in the establishment and operation of North Atlantic air services between the three countries, with base at Newfoundland, according to V. S. Bennett of St. John's, N.F. United States interests are headed by Smith, Barney & Co., investment bankers, New York, who say they have had a leading part in the financing of U. S. airlines. Company is surveying operating conditions and negotiating for rights of entry.

Discontinuing 23 Towers

Operation of 23 traffic control towers in 23 cities is being discontinued by CAA because the AAF has withdrawn funds allocated for that purpose. CAA took over the towers at request of the Army because of heavy military traffic in the regions involved. The Army Supply Act of 1941 authorized this service by CAA. There are 115 such towers (including those being eliminated). Many of the towers existed as municipal activities before the authorization was passed.

SURPRISE FOR PRESIDENT PATTERSON

Completing 10 yr. as president of United Air Lines and 15 yr. service with company, W. A. Patterson received a surprise award from a representative employees' committee—a silver plaque lauding his leadership and signed by 667 employees who worked under him through the decade. Presenting plaque to Pres. Patterson is O. E. Kline, lead mechanic at Chicago, while looking on are (left to right): R. Edwards, Chicago station manager; N. Fry, acting general traffic manager; A. Akins, Mr. Patterson's secretary; H. Knoop, superintendent, eastern flight operations; L. Davis, auditor of general accounts; and B. McMahon, Chicago passenger service.

UAL Employment Plan

United Air Lines has a continuing program to get back its 1300 employees who have gone to war and to re-train them, when required, in the new procedures of flying, operations, communications, maintenance, etc. Russ F. Ahrens, United's personnel director, is in charge. United personnel has expanded from 4,300 in 1941 to nearly 8,000 in 1944. Company estimates that figure will climb to 18,000 within four years after the war. Ahrens is keeping in contact with his 1,300 service men and women by mail, finding out their aspirations by questionnaire.

Re Transport Weight Rises

Pilots from all of the airlines testified, in recent CAB hearings, against promulgation of the CAB authorization, first proposed about a year ago, to increase takeoff weight of the Douglas DC-3 by 1,000 lb. and landing weight by 800 lb., also to "up" both landing and takeoff weights of the Lockheed *Lodestar* by 1,000 lb. Increases would apply only to ships fitted with Wright G-202 or P. & W. S1C3G engines, and then only under proper flight conditions. Pilots related unhappy experiences and said the DC-3 is a '36 model no matter what power is added; CAB engineers meanwhile quoted figures supported the poundage rises. Outcome of the controversy is as yet unpredictable.

Traffic in Broad Gains

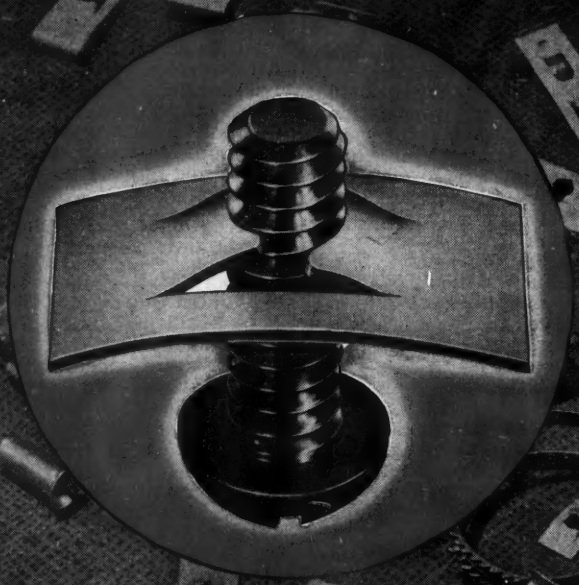
ATAA reports sharp gains in first quarter operations of domestic airlines. In this period, revenue passenger miles were estimated to exceed 465½ million, a 40 percent "up" over the first quarter of '43. Other figures were 22½ billion mail pound-miles (against the old 15 billion); 36 million mail pounds carried (against 23½); 9½ billion express pound-miles (against 6½); and 19½ million express pounds carried (against about 13).

United Seeks Hawaii Run

Applications have been filed by United Air Lines for franchises that would add 16 new stops to its coast-to-coast and Pacific Coast airways network, also for a new line between the Pacific Coast and Hawaii,

Over 2000 Assembly Short Cuts

With Speed Nuts



The SPEED NUT System of spring-tension fasteners comprises more than 2000 shapes and sizes. Back of each and every design was a new reason, hence a new method to improve specific assembly jobs.

In some cases, certain parts are completely eliminated. In other cases riveting operations or drilling of holes is dispensed with. Many SPEED NUTS hold themselves in screw-receiving position. Dismantling of parts for service or repair is often made twice as easy. And in every case, weight is reduced from 50% to 70%, time is generally cut in half and net assembly costs hit a new low.

Hundreds of metal, wood, and plastic products have already been fastened better in over 2000 ways with SPEED NUTS. Use more of them to fullest advantage now. If in doubt on correct shape, send blueprints for quick help.

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*Trademark Reg. U. S. Patent Office

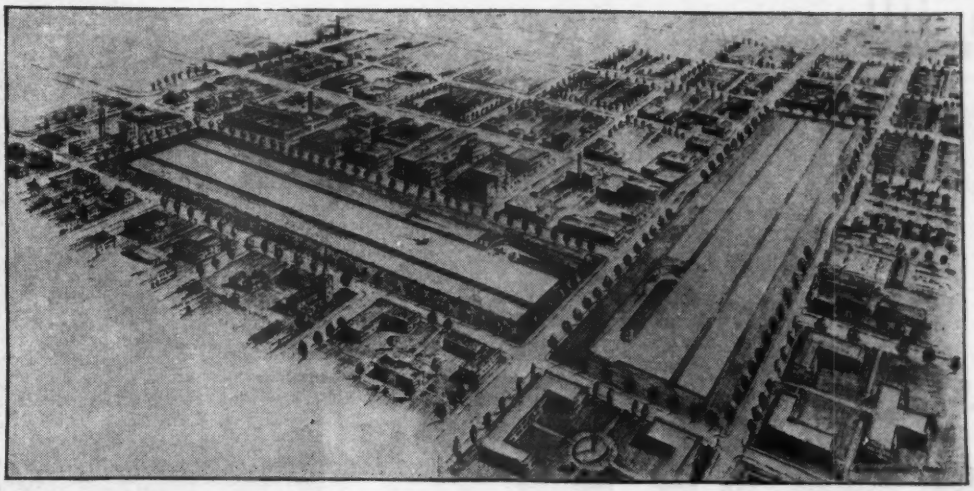
Fastest Thing in Fastenings

W. A. Patterson, United president, has announced.

The 16 new stops, which would add 20 western cities to those now serviced, are: Ogden, Utah; Twin Falls, Ida.; Baker, Ore.; The Dalles, Ore.; Lewiston, Ida.; Clarkston, Wash.; Yakima, Wash.; Aberdeen-Hoquiam, Wash.; Olympia, Wash.; Centralia-Chehalis, Wash.; Astoria, Ore.; Marshfield-North Bend, Ore.; Bend, Ore.; Chico, Calif.; Eureka, Calif.; Santa Rosa, Calif.; and San Luis Obispo, Calif.

On the proposed Hawaii route United plans to use four-engined, 52 passenger planes, presumably DC-4's.

S. V. Hall, company regional vice-pres. at Denver, has been appointed manager of United military operations for the Air Transport Command in Alaska and the Pacific.



FOR PRIVATE FLYERS ONLY

Here's a personal plane airport for congested areas proposed for St. Louis by Oliver Parks, of Parks Air College and member of city's Aviation Commission. Such a downtown port would have 1,600-2,000-ft. landing strips with total width of a city block. Underpass (see detail) would connect strips, and but two streets would have to be closed for each strip. Parks also has plans for outlying skyports.

Launch New WAL Service

Service was inaugurated between Los Angeles and San Francisco, by Western Air Lines, on May 1. Three daily round trip schedules will take off alternately from Mills Field, San Francisco, and Lockheed Air Terminal, Los Angeles, all operating on a two-hour non-stop basis. Douglas DC-3 planes are being used in this service.

Roy Backman has been appointed district traffic manager of the Line's new San Francisco office, temporarily located in the St. Francis but soon to be established at 287 Geary St. He is assisted by Clay Bernard, Tempest Williams, and Margaret Robinson. Operations offices at Mills Field are under the supervision of Joseph L. O'Neill.

Route Applications

Airline route developments: Oklahoma Airlines, new organization, will apply for a system of lines around Oklahoma City . . . Engel Aircraft Specialties has filed for three feeder routes out of San Diego . . . Pueblo Air Service, until recently a training school, asks for routes in southeastern Colorado . . . Fourteen fixed base operators forming Consolidated Airlines have asked for 64 routes in central states . . . Alaska Airways and Woodley Airways file for mail service between Anchorage and Kodiak . . . Ryan School of Aeronautics files for trans-Pacific service from California to Calcutta, India, with a branch at Canton, China, 13,760 mi. in all, also for another route between Los Angeles-San Diego and Havana, Cuba . . . Seas Shipping Co. asks for certificate to parallel by air their ship line between New York and South Africa . . . Aero-Transportes, S. A., Mexico City, asks for permission to operate from Piedras Negras, Mexico, to San Antonia via Eagle Pass, Tex. . . . And Fish Airlines Corp., New Bedford, Mass., wants to transport seafoods to points in Eastern states.

Re Swivel-Wheel Gear

Light plane builders and pilots were reported increasingly interested in swivel wheels for cross-wind landing. Experiments recently made in England are being followed up in this country. The idea is not new; it was tried out long ago. Recent tests by a light plane builder showed that crosswind landings are easily made with wheels independently swiveled, swiveled and connected by a tie-rod, or held semi-rigid by springs. If swivel wheels should prove practical on planes of all sizes, it would make a vast difference in the cost of airports, many of which could get along with single or parallel runways.

About 73-Octane Rationing

OPA was getting ready, at this writing, to tighten rationing of 73-octane aviation gas, used mostly by personal and by fixed base services. Gasoline is rationed to these classes by local boards, and there have been a few chiselers. Now CAA has offered to certify plane owners entitled to gas rations, also to tabulate the amount of fuel required for various power ratings. There is actually more gasoline for flying than ever, since WTS and contract training are being stopped

★ CROSS COUNTRY ★

Two American Export Airlines pilots lowered the commercial record for non-stop trans-Atlantic flights: Capt. Edward A. Stewart left New York Apr. 15, and arrived in Ireland Apr. 16—time 15 hr. 51 min. Capt. Charles A. Thompson left New York Apr. 19 and arrived in Ireland Apr. 20—time 15 hr. 30 min. Planes were the VS-44A Sikorskys.

Continental Air Lines has been authorized by the CAB to extend its present routes to include operations between Hobbs, N. M., and San Antonio, Texas.

Special mechanical equipment for spreading cement in soil-cement surfacing has been developed by CAA and Halliburton Oil Well Cementing Co., and all equipment can be transported by air.

United Air Lines ton-miles flown increased 49 percent in March over same month in 1943, it was recently reported.

Operators of small airports in New England have organized as a permanent group to promote development of aviation and help with problems at any and all New England airports.

Atlantic Coast Express, Richmond, Va., has been granted a charter by Virginia State Corporation Commission to do air and motor transportation business.

American Airline figures were up for first quarter, with revenue passenger miles increasing 10.9 percent to 102,117,357. Total revenue miles flown increased 8.3 percent. Pound miles flown in the three months were 4,770,-919,722, an increase of 45.2 percent, and express pound miles increased 11.2 percent.

CAA has published following pamphlets: "Aircraft Corrosion Resulting from the Use of Calcium Chloride on Airport Runways," by C. J. Janes of Technical Development Div. and "The Establishment of a Restricted Area for Seaplane Operation," by F. H. Grieme, Technical Development Division.

Braniff Airways has been granted an amended certificate to serve Topeka, Kan.

Pan American World Airways System has inaugurated daily round trip passenger flights between Rio de Janeiro and Sao Paulo.

Formation of the New York Air Commerce Committee is announced by Chairman John F. Budd, of the Aviation Section, New York Board of Trade. Purpose is study of the roles various industrial officers should play in the coming air commerce.

For use of its Latin American "Clipper" clientele, Pan American World Airways System has printed two vest pocket "flying language dictionaries," one printed in Spanish and English, the other in Portuguese and English.

An "international travel packet" is being issued by Continental Air Lines to its Mexico City passengers. The packet contains pockets for tickets, baggage checks, passports, etc., also includes a small pad for notes and a check list.

Airport Section of CAA's Technical Development Div. has developed a special searchlight at request of Airline Pilots Association. Designed for use in conditions of low visibility and where smoke conditions prevail, light beam pivots from a vertical position down to a near horizontal position where it indicates the direction to the airport. In smoke and haze, light is visible at about 1,000 ft. CAA pilot tests have proven it effective, and airline pilots will test it soon.

Application for a new route between Washington, D. C., and Montreal, Can., has been filed by Pennsylvania-Central Airlines.

Lexington Flying Service, Inc. applied to the Kentucky Aeronautics Commission for permission to operate planes strictly intrastate between Lexington and two other large cities in the state and it has already bought two five place planes.

Compania Mexicana de "Aviacion, Mexican affiliate of PAA, announces additions to its service between Mexico and the U. S. and Mexico and Cuba.

KEEP PRODUCTION LINES

ON THE BEAM with

Casters incorporate the famous Service FORGEWELD unbreakable construction . . . easy rolling casters good for loads from 1000 to 6000 pounds, or whatever your requirements. Can be operated on or off angle track as needed.

SERVICE FORGEWELD GROOVED WHEEL CASTERS

Picture your production line with work units mounted on Service ForgeWeld *Grooved Wheel Casters.* Jigs, trucks, dollies, or special assembly units roll along in a straight, smoothly-flowing line. Work comes to the workers at various points along the line. There's your set-up for important time savings, faster assembly, and conservation of floor space. It's today's most practical way to make every man and every minute count for more. And it's easy to install, simple to re-arrange when needed.

How can this modern, production-speeding development be applied to your operations? You can probably think of several ways right off. For practicable suggestions on how Service Grooved Casters on Wheels can help you, talk to a Service representative. Write us today.

HERE'S HOW IT WORKS

All that's needed for a straight-line system is to embed angle iron track in the floor (or simply join and lay track on the floor)... then mount Service ForgeWeld Grooved Wheel Casters under work units. That's all. Write today for further details.

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CASTERS, TRUCKS AND SPECIALLY DESIGNED LIFTING AND HAULING UNITS

U.S.-Britain Now Agree on Basic Postwar Air Principles; International Body Planned

British plants building postwar craft; Americans irked . . . Minor Lines meet to form air traffic group.

Britain, it is announced, has "reluctantly" agreed to certain basic precepts set up by the United States for postwar commercial aviation. The plan, to be known as the "four freedoms of the air," would give any certified United Nations airline the right to fly, land, discharge, or pickup passengers at any airport in the world. This plan is in decided contrast to a previous Canadian plan which would have rigidly fixed services, schedules, and number of passengers.

The American plan involves the establishment of an international body to regulate air traffic as to safety, economic aspects, and other factors, at the same time eliminating cutthroat competition.

While the British gave in to the United States on the freedom of the air plan, the demands in some official American quarters that this country acquire permanently the bases which have been built for the ATC were flatly turned down by Lord Beaverbrook. These bases would be controlled by the proposed international authority, he said, and would therefore be available to the airlines of the world.

At the same time, Lord Beaverbrook suggested that present or proposed lines may offer concrete plans to the Government if they objected to the BOAC "chosen instrument" policy.

Swing of British policy to the American viewpoint represents a major victory for Berle and Warner. Even if only the British Empire and the United States agree, 'round-the-world airlines can easily be established networking British and American possessions.

British Plants "Previous" On Postwar Craft

Certain British manufacturers seem to be starting active production of commercial transports, even selling them to airlines, and accordingly something of a roar has arisen in the United States.

In April, this department told of initial construction on the "Tudor"; moreover other British plane conversions were reported. Apparently these programs have progressed further than was originally known, judging by the announcement from England that KLM has placed a substantial order for "Tudors".

This news does not seem to "gee" with a recent statement by Lord Beaverbrook that since American aircraft producers were concentrated on large bombers, they could more easily convert to passenger plane production, and that with British plants concentrated more on fighter production, America would have to lend-lease or sell commercial aircraft to Britain and other countries until such a time as British plants could develop and place into production their own commercial planes.

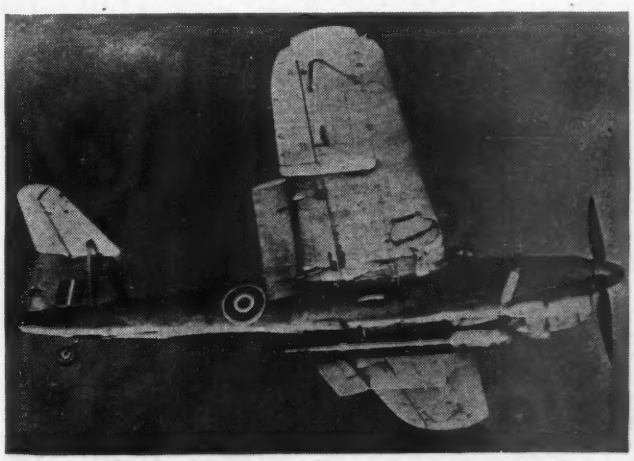
There seems to be some conflict between facts and official pronouncement, and U. S. manufacturers, who in the past sold a considerable part of their output outside the United States, feel that if the British are allowed to develop and build postwar planes they, too, should be allowed to divert at least part of their facilities to the building of aircraft which would open international markets for them.

Minor Lines Meet to Form Air Traffic Group

Airline operators from eight countries recently met to form a new international airline association, to be known as the Conference of International Air Traffic Operators.

Caller of the conference was the small independent British North Eastern Airlines, which identified the meeting's main purpose as a discussion of the postwar problems which would face the smaller countries, particularly the obtaining of necessary air equipment.

Some circles look upon this get-together as an attempt to force the hand of the "Big Three" on postwar commercial aviation plans, but at this time no definite information seems to be available.



TORPEDO-TOTING "BARRACUDA"

Latest British torpedo bomber is this Fairey "Barracuda," which damaged the "Tirpitz" in its fjord hideout. Powered with a "Merlin," top speed is 254 mph at 12,000 ft. Novel features are wing-root baywindows for navigator, very high stabilizer, and unique flaps. Latter can be placed at various angles to serve as auxiliary lift devices in takeoff, as diving brakes, and also as landing flaps. The "Barracuda" is for use on carriers. Its wings fold back toward tail like those on Grumman "Avenger." Landing gear of the new plane is of very narrow tread, and for this reason auxiliary wingskids (see photo) have been installed. Note underwing vanes between aileron and flap; these are undoubtedly used to add lateral stability by smoothing out airflow over rear part of wing and flap. (Acme photo.)

ON SCHEDULE . . . . . By "VISTA"

News that KLM Royal Dutch Airlines had placed an order for early delivery of a substantial number of Britains' forthcoming "Tudor" transports came as a surprise to many persons in American aviation.

Background and development of this line makes this choice of new equipment curious, since KLM had been using U. S. airplanes exclusively since 1935, building up excellent Europe and Far East airline networks with them. A further question arises: Will KLM now cancel its rather substantial order (booked in '39) for large Lockheed transports of an advanced type?

Experience has certainly shown that two different type craft in one operation do not mix. As a solution, KLM would have to concentrate on the use of one type, and in view of the size of the "Tudor" order, the company apparently has decided to base all on the Tudor, an as yet unknown and unproved airplane. And so the question: Is a trend away from American equipment to be expected?

Well informed quarters trace the company's action to the new management installed by the exiled Government, certain members of which have for a very long time fought every purchase of American equipment with the claim that Netherlands' own industry (Fokker) could build better and cheaper aircraft. In 1939, sanction for the purchase of Lockheeds was only obtained after the KLM agreed to call upon Fokker for a new type plane to be known as the F-24. The latter craft cannot be obtained, but the pressure apparently is still sufficient to force purchase of English transports.

★INTERNATIONAL BRIEFS★

Polish interests have opened an aero department in London, possibly aiming for post-war re-establishment of the LOT lines.

RAF Fighter Command has been dissolved in favor of establishment of two new groups, the Tactical Air Force and the ADGB (Air Defense of Great Britain).

Arrivals and departures at Foynes, Ireland, are reported averaging around 675 per month.

Bristol has set up a permanent "Aviation Corner" on Piccadilly in London, a showroom available to anyone connected with British aerial interests.

Misr Airlines, largest company in Egypt, has plans for an airline to England as its initial international venture.

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No nation that has known the might of airpower in war will ignore the aid of the airplane in peace . . . And Air Associates will be ready to resume the role it has held since 1927 as prime purveyor to aviation . . . to serve old customers and new wings over the Orient . . . to work together with government, airlines and private owners . . . In addition to standard stocks and many exclusive items, we will be able to offer new specialties of our own design, engineering and manufacture, war proved and service tested . . . Consider Air Associates as first aid in any aviation program for tomorrow, at home or abroad.

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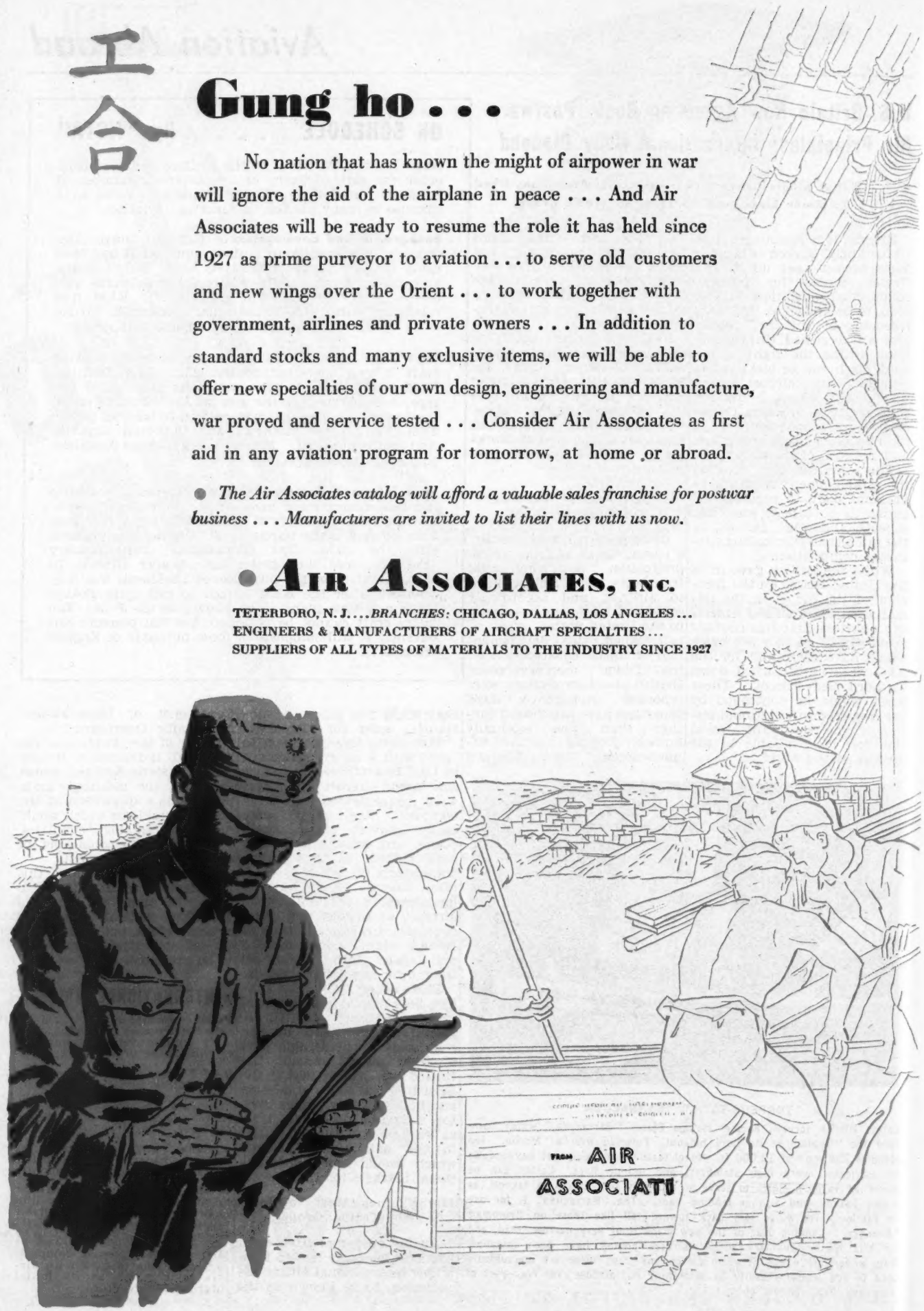


Boeing Airplane Co. reports net sales of $493,188,166 in 1943 against $386,567,316 in 1942, while net income dropped to $4,482,870 or $4.14 a share from $5,237,624 or $4.84 a share in 1942, despite the large increase in volume last year. A postwar refund of $2,545,000 in 1943 and one of $2,860,000 in 1942 were both transferred to a reserve for development of postwar products and markets.

Transcontinental & Western Air has purchased a 20 percent interest in Hawaiian Airlines, Ltd., from Inter-Island Steam Navigation Co. at a cost of $300,000. The Hawaiian concern has a fleet of six planes engaged in passenger, mail, and cargo service in the islands. The steamship company expects to divest itself of control of the island airline as soon as the latter is permitted to extend its service to the Pacific Coast. Hawaiian Airlines had a gross of $1,613,073 and net of $132,054 last year.

Lockheed Aircraft Corp. reports sales of $697,408,167 last year against sales of $491,160,471 in 1942. Net profits were $7,988,420 or $7.42 a share in 1943 compared with $8,163,721 or $7.59 a share the previous year. Reserves for postwar adjustments at the end of 1943 totaled $18,052,000 against $12,661,000 in 1942. Notes payable were listed at $90,000,000 on the 1943 balance sheet.

Luscombe Airplane Corp. reports net profit of $159,153 or 46c. a share in 1943. Gross sales, after voluntary price reductions of $116,000, were $3,229,250 against $1,028,300 in 1942. The balance sheet revealed current assets of $1,205,672, including cash of $174,237, against current liabilities of $789,712. Notes payable were $200,000.

Liberty Aircraft Products has acquired 56,468 shares of its common stock from Grumman Aircraft Engineering Corp. Liberty does not intend to reoffer this stock which Grumman bought from it in 1940.

Jacobs Aircraft Engine Co. reports sales of $63,915,622 in 1943, after a voluntary refund of $5,000,000 to the Army Air Forces, against sales of $34,437,464 in 1942 following a $4,500,000 tentative renegotiation settlement. Earnings were $1,890,568 or $3.05 a share against $1,708,478 or $2.76 a share in 1942. Earnings last year are subject to renegotiation, and there is a renegotiation claim of $500,000 outstanding on 1942 profits in addition to the tentative settlement by the regional board as mentioned above.

ADDING IT UP . . . . By RAY HOADLEY

The real "war babies." Stock market prices bear more relation to postwar prosperity than to wartime earnings, according to a Commerce Department study of the stock market. In the case of the aircraft stocks, the market has been on a downward trend since 1940, in the first quarter of 1944 being about 30 percent below that of 1939. On the other hand prices of the automotive group, rubber concerns, and many others, are higher than in 1939. No wonder the aircraft stocks are no longer called "war babies."

Postwar taxes. In another interesting study made by the Harvard Business School, the rapid growth of Lockheed Aircraft Co. in the 1930's is analyzed to show that high postwar corporate income taxes would seriously curtail the expansion of small business concerns. It was found that Lockheed's remarkable prewar expansion would have been virtually impossible in the face of corporate tax rates likely to prevail in the postwar decade. If Lockheed had had high tax rates during its early expansion, the report shows that bankruptcy would have been almost inevitable.

Lockheed's case. Development of the *Electra* transport was undertaken by Lockheed in 1933 with assets of less than $200,000 and net working capital of about $75,000. Output of other models had to stop, and large amounts of outside capital had to be secured from stockholders and customer advances. At the end of 1934, Lockheed had only $72,000 in current assets other than inventory with which to meet $269,000 of current liabilities. If the *Electra* development had failed, bankruptcy would have been certain. But if a large firm making other products had undertaken such a project, any losses would be deductible from income earned from other activities. Thus the long-established firm would not be seriously deterred from developing new products by a high tax rate.

Surplus disposal. Beech Aircraft Co. is well on the way toward solving its surplus disposal problems through formation of a separate Beech-owned company to take over excess materials. In its first three months of operation, the new company moved about $300,000 worth of materials a month. Inventories can be transferred from the parent concern, a fact that should both simplify and speed contract termination procedure.

Across the border. Canadian aircraft manufacturers are in about the same boat on war business as their American neighbors, judging from the 1943 report of Noorduyn Aviation. Pointing out that Noorduyn, with small original capital and large turnover, is in a vulnerable position, the report stated that the present Canadian tax policy (100 percent on excess profits) neither allows incentive nor permits the company to insure its immediate postwar position.

Termination financing. Barney Baruch, who laid down the blueprints months ago for Congress to follow in termination legislation, is known to fear that the lawmakers may not get around to passing a suitable bill before the elections. If Germany should suddenly quit, as she did in 1918, that would mean that no means would be readily available to finance the termination loans that industry will have to have when the cancellation telegrams are rushed out from Washington. Main reason for the delay in Congress, Baruch tells his friends, is the development of many side issues in the termination bills—issues that are all good for weeks of argument on the floor, such as wage dismissal provisions and supervision of terminations by the general accounting office.

New Air Companies: Dunkirk Aeronautical Corp. has been incorporated at Buffalo, N. Y., with a capital of 200 shares. Marvin Morrison, Louis Morrison and Helen Hapke are the incorporators . . . Carl Dolan Corp., newly formed firm in New York City, has purchased machinery and equipment of Essential Industries Corp. . . . Oklahoma Airlines has been formed to seek CAB approval to serve a trade area of smaller communities around Oklahoma City. T. E. Braniff, president of Braniff Airways, is reported to have put in $25,000 of the $100,000 in capital already subscribed.

United Aircraft shipments in the quarter ended Mar. 31, 1944 were $215,280,014 while net profit, subject to renegotiation, was $4,060,628 or $1.40 a common share. Postwar adjustment reserves of $2,170,000 were deducted from earnings.

Aircraft Accessories Corp. reports net profit for the nine months ended Jan. 31, in excess of $715,000 or $1 a share. Sales were more than $26,000,000 and volume now is running close to $4,000,000 a month.

Fairchild Orders: Backlog of Fairchild Engine & Airplane Co. was around $165,000,000 on Mar. 31 compared with $140,000,000 at the end of 1942. Fairchild Camera & Instrument Corp. reports unfilled orders "sufficient to keep plants busy for some months to come." Sales of Fairchild Engine in 1943 were more than double those for 1942 according to Pres. J. Carlton Ward, Jr., while Pres. James S. Ogsbury of Fairchild Camera report 1943 sales of $52,056,000 against $17,727,000 in 1942. Annual reports of both companies have been held up by renegotiation proceedings.

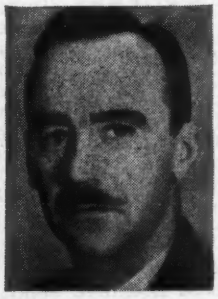
Warner Aircraft Corp. reports net profits for 1943 of $169,689 or 34c. a share compared with net profits of $87,288 or 17c. a share for 1942. Last year's earnings are subject to renegotiation while the 1942 figures are after renegotiation.

Thompson Products reports sales of $35,769,983 for the quarter ended Mar. 31 against $30,112,251 in the like 1943 period. Thompson Aircraft Products Co. accounted for $14,410,859 of the 1944 gross and $11,591,291 of sales in the like 1943 quarter. Net earnings were $798,006 or $2.47 a share against $718,089 or $2.31 a share in the same quarter of 1943. Voluntary price reductions of $30,000,000 have been made on shipments already completed, according to Pres. F. C. Crawford.

National Aviation Corp. reports an indicated net asset value of $16.42 a share on Mar. 31, while net income for the three months ended Mar. 31 was $23,913.

Aviation People

CAPT. AUDREY D. DURST, who has flown for Pan American since 1930, was named chief pilot of the Atlantic Division to fill the vacancy created by the appointment of Capt. Harold E. Gray as division manager of operations. (Pan American photo.)



JOSEPH M. BARR, assistant general manager of the Chance Vought Aircraft division of United Aircraft Corp., has been named manager of the export department of the corporation and has relinquished his former duties at Chance Vought.

GORDON G. JOHNSON is appointed plant manager of the Lycoming division of The Aviation Corp. He has been acting plant manager and previously, controller of The Aviation Corp. He also served for a period as assistant treasurer of Lycoming.

DR. STEPHEN J. ZAND, director of the Vose Memorial high altitude laboratory of the Sperry Gyroscope Co. at Great Neck, L. I., N. Y., has been elected a Fellow of the Royal Aeronautical Society, the 13th American to be so honored. (Sperry photo.)

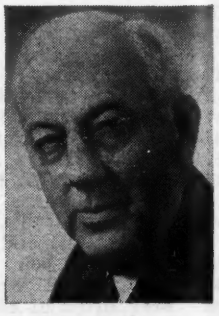
COL. JOSEPH BENJAMIN PATE, recently retired from active duty in the Regular U. S. Army, terminating 42 yr. of military service, has been appointed special representative for **TACA** Airways System and will be stationed in Washington, D. C.

HOWARD L. HARTMAN has become executive assistant of the Chance Vought Aircraft division of United Aircraft. In his new connection with United he rejoins the organization which he served for 11 yr. in the Pratt & Whitney division. (Piver photo.)

EUGENE W. WASIELEWSKI was appointed chief engineer for McCulloch Engineering Corp. Formerly with the NACA working on design of superchargers, he has aided in supercharger development work with Fairchild Engine subsidiary companies and Stratos Corp.

T. C. SULLIVAN is appointed assistant to the president of United Aircraft Corp. He was formerly with the Wall Street News, then joined the Wall Street Journal in 1935, in 1940 joined Vultee Aircraft, Inc., as asst. to the president and secy. of the corporation.

E. B. SPORLEDER, executive engineer of Douglas Aircraft Co., was named national chairman of the Airworthiness Requirements Committee of the Aeronautical Chamber of Commerce of America at the recent first annual meeting of the Committee.

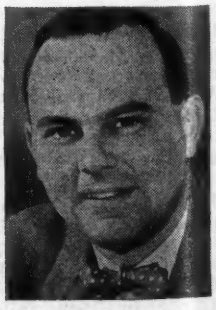


EVAN E. YOUNG, who has been v.p. in administrative charge of Pan American Airways' air transport routes in Latin America, has retired from active duty. Before joining PAA, he served as minister to the Dominican Republic and Republic of Bolivia.

ARMAND J. GARIEPY, appointed contracts and service manager for Lawrance Aeronautical, will direct the service department, also contracts, advertising, and public relations. He was formerly with RDC Aviation Division.

DR. DONALD HILLS DAVENPORT, former college professor and government economist, has taken up the duties of Director of Business Research for the Curtiss-Wright Corp., Airplane division, with headquarters at Buffalo, N. Y.

WILLIAM B. BIRREN has been named sales and service manager of Wright Aeronautical Corp. He has spent more than 27 yr. in the aviation industry both in field service and engineering work, and before taking over his new duties he was service manager of Wright Aeronautical (since 1940). Simultaneously with his appointment, **JOHN T. WETZEL** was named service manager. His association with Wright began in 1931, and he has been in the service department since that time.



KARL P. GRUBE has been appointed manager of Douglas Aircraft Co.'s newly created corporate termination claim committee, established to formulate and administer company policies and procedures essential to contract matters.

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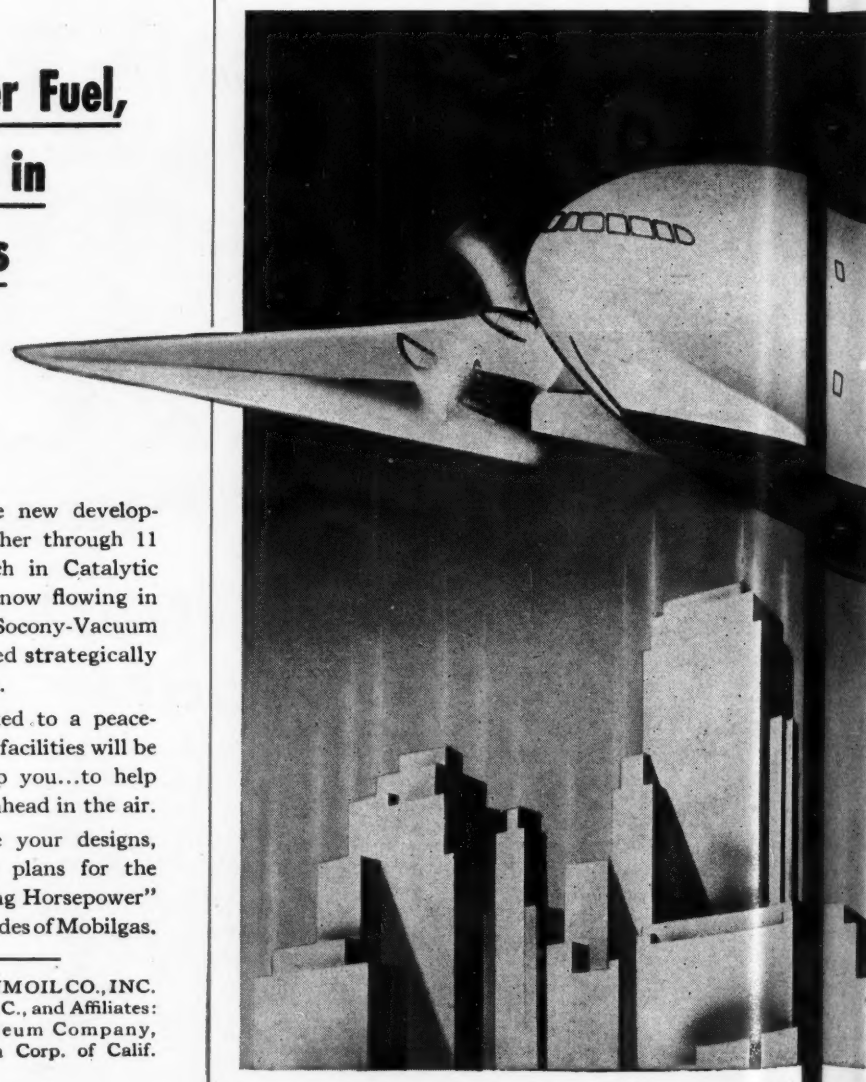

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ENGINEERING DATA

Combustion Data 1

Hauck Industrial Combustion Data, 112 pages of data on industrial combustion and heating practice, is a reference book for those concerned with selection, installation, operation, and maintenance of combustion equipment, oil or gas, on furnaces, ovens, kilns, retorts, etc. Issued by Hauck Mfg. Co., Brooklyn, N. Y.

Radius Charts, Etc.....2

Bulletin 1-44er, from Universal Eng. & Colorplate Co., Buffalo, covers complete line, including several new items, of radius charts, protractor charts, scales, and rules for use on all makes of optical comparators, measuring and micro projectors. Companion booklet, *Specifications and Prices,* lists models of projectors or comparators on separate page, in conjunction with sizes of recommended charts.

Aircraft Heaters 3

"Whirl flame" operating principle of new surface combustion type "Janitrol" high altitude aircraft heater is described and illustrated in new bulletin issued by Surface Combustion Co., Toledo. Unit is designed to meet all requirements of modern high altitude aviation.

Porous Metal Filtering.....4

As filtering element in aircraft engines, "Porex", produced by powder metallurgy by Moraine Products Div., General Motors, Dayton, Ohio, is described in booklet. Given are examples of shapes commonly used, fields of application, information on design, and engineering data, including thickness table, particle stoppage table, limitations on size and shape, physical properties, directions for use of flow curves, and viscosity conversion chart.

Synthetic Resins 5

Bulletin No. 6 from Resinous Products & Chemical Co., Philadelphia, contains technical data for users of plywood in aircraft. It is stated that one of the new synthetic resins makes possible a utilization of higher percentage of all veneers delivered by manufacturer and solves problem of repairing split sheets.

Buyers Encyclopedia 6

A buyers' encyclopedia featuring more than 500 items in industrial maintenance, safety, and fire protection fields is offered by General Detroit Corp., Detroit. Given is factual data on sizes and types of hose threads, nozzle and fire stream data, and proper maintenance of fire hose.

Retainer Rings 7

Engineering Folder No. 43 released by Eaton Mfg. Co., Reliance Div., Massillon, Ohio, covers engineering data on retaining rings for SAE standard bearings, housing and shaft applications. Contains general information and ready reference on dimensions, and cuts, and steel sections, for engineering, designing, and purchasing.

Plywood 8

Aetna Plywood & Veneer Co., Chicago, announces *Victory Book,* in color and profusely illustrated. Offered is information on "Plywood In and After Victory" and copyrighted feature, "Teleply Ticker"—late data about availability of plywood and veneer.

PRODUCTION

Packing War Material 9

Speed Packing Manual for War Material, issued by Sherman Paper Products, Newton Upper Falls, Mass., contains section on protection against corrosion and digests materials issued by various branches of armed services to give shipping men a brief, accurate explanation of methods. References to original specifications are included.

Screw Thread Inserts.....10

"Heli-Coil" screw thread inserts, used as anti-friction thread lining or bushing for tapped threads of American National Screw Thread System, together with necessary tools, are described in bulletins issued by Aircraft Screw Products Co., Long Island City, N. Y. Also given are specifications and design and installation data.

Hot Coiling of Springs.....11

Folder published by Muehlhausen Spring Corp., Logansport, Ind., illustrates and describes methods used in hot coiling large springs. Shown in sequence are various steps in manufacturing, facilities necessary, also operations required.

Metal Bellows 12

Principles, construction, and engineering advantages of "Spring-life" bellows are portrayed in new catalog issued by Cook Electric Co., Chicago. Photographs and diagrams aid explanations of characteristics and construction, and included are application chart and suggestions for selection of proper bellows for specific requirements.

Aluminum Alloy Extrusions.....13

Conservation Bulletin No. 8A, aircraft Production Board, discusses extrusion situation, and attention is called to NASC catalog of aluminum alloy extrusion dies and catalog of rolled form sections.

Soluble Cutting Oils.....14

Soluble Cutting Oil at Its Best discusses problems involved in selection and application of water-mix oils. Illustrated with photos of machining operations and laboratory tests. D. A. Stuart Oil Co., Chicago.

Conduit and Conduit Fittings.....15

Bulletin A-60, from American Brass Co., Waterbury, Conn., replaces *Bulletin A-48,* illustrating and describing American flexible shielded conduit, shielded conduit fittings, and other aircraft products.

Waxes 16

Waxes for Today and Tomorrow, from Distributing and Trading Co., New York, technically discusses various waxes, substitutes, and extenders. Listed are 36 kinds, with specifications.

Lubrication Program 17

Sun Oil Co., Philadelphia, announces *Save and Serve Campaign,* a program to help industry save time, machines, and labor. Comprises booklets, wall charts, posters, folders, technical bulletins, and maintenance memos.

Hard Rubber 18

Distinctive qualities of hard rubber are listed in new catalog from B. F. Goodrich Co., Akron. Applications of various types are listed, also kinds of products which can be successfully made from material. Suggestions for working are given.

Blind Riveting Manual.....19

Cherry Rivet Co., Los Angeles, has published new manual on use of company's rivets. Illustrated in color sketches, manual covers description of blind rivet, drilling of hole, selecting of rivet, pulling head, installation procedure, etc.

Fasteners 20

Fasteners is title of booklet issued by American Institute of Bolt, Nut & Rivet Manufacturers. Explained is inauguration of a program of technical research. Contains several articles, illustrations, and factual material.

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NAME.....TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

Graphite Parts 21

United States Graphite Co., Saginaw, Mich., has published a booklet on product "Graphitar", describing its characteristics and application, such as in rotary pump blades, turbine packing rings, rotary pressure joint seals, clutch release bearings, pump seals, piston rings, and metering disks.

MACHINERY & ACCESSORIES

Hydraulic Test Machines.....22

Machines for testing aircraft hydraulic systems, for inspection and operational testing of single or complete line of hydraulic components, or for research and development testing, are described in bulletin from Greer Hydraulics, New York

Locating Spotlight 23

Bulletin from Sciaky Bros., Chicago, illustrates and describes a locating spotlight for use on wide range of production machinery.

Broach Pull-and-Push Heads.....24

Broach Head Circular, from American Broach & Machine Co., Ann Arbor, Mich., covers all types of Broach pull-and-push heads.

Tensile Tester 25

Bulletin from W. C. Dillon & Co., Chicago, describes company's tensile testers, their construction features, and applications to precision testing.

Spot Welders 26

Manual and automatic spot welders made by Pier Equipment Co., Benton Harbor, Mich., are shown in recent catalog. Details of important parts, regulator controls, and automatic weld timer are given. Welding capacity charts for all welder sizes and different throat depths are included.

Rotary Shears 27

New illustrated bulletin on Kling rotary shears, made in six sizes, is offered by Kling Bros. Engineering Works, Chicago.

Electric Test Instruments.....28

Catalog describing multitesters, vacuum tube testers, insulation testers, electronic voltmeters, limit bridges for precision resistance testing, combination tube, battery and set testers with plug-in analyzer units to meet requirements of aircraft production testing, laboratory, and shop purposes, is offered by Radio City Products, New York.

Truck-Tractors 29

Illustrated and with specification data, new vest pocket catalog of factory trucks and tractors has been issued by Clark Equipment Co., Battle Creek, Mich.

Air Compressors 30

Catalog illustrating and describing Sullivan air compressors, accessories, and installations is offered by Sullivan Machinery Co., Michigan City, Ind.

Current Regulator for Welders.....31

How to control current variations in welding is subject of bulletin from General Electric Co., Schenectady. Application, description, and operation of current regulating compensator is given.

Welding Equipment 32

Booklet from Victor Equipment Co., San Francisco, is story-picture of company's products and their applications, published for the enlightenment of users, employees, and stockholders.

Gages 33

Haines Gage Co., Philadelphia, has published a bulletin featuring a wide variety of made-to-specification precision gages—plug, ring, snap, flush pin, and profile.

Infra-Red Case Histories.....34

Brochure from Fostoria Pressed Steel Corp., Fostoria, Ohio, offers case histories of drying and heating problems with infrared equipment, referring particularly to small installations.

Gear Pullers 35

Gear pullers, among other scarce tools, are now coming into stock, according to announcement from New Britain Machine Co., New Britain, Conn.

Hole Punching Units.....36

Catalog describes Wales hole punching units which punch series of holes simultaneously in extruded and shaped sections. Maker is Wales-Strippit Corp., North Tonawanda, N. Y.

Dust Control 37

Catalog of dust collectors, with complete engineering information, applications, list of users, etc., is offered by Pangborn Corp., Hagerstown, Md. Company also is issuing condensed catalog of equipment for various types of blast cleaning equipment.

Carbide Tool Blanks.....38

Carbide Tool Co., Detroit, announces line of standard Carboloy tungsten carbide tool blanks from stock, in bulletin just issued. Total of some 640 types are available.

ELECTRICAL

Electric Instrument Parts.....39

New parts publication, prepared by General Electric Co., Schenectady, covers 2½-in. d.c. and r.f. ammeters and voltmeters of new internal-pivot design for aircraft. Illustrated are parts "exploded" in proper relation to each other.

Insulation Tester 40

Bulletin No. 445 from Herman H. Stight Co., New York, describes new model C-2 Megohmer (insulation tester). Unit is stated to be a radically new development inasmuch as new spillproof lightweight storage battery is used as power supply.

Snap Action Relay.....41

Engineering data bulletin describing redesigned 79XAX snap action relay and giving circuit application diagrams is offered by Struthers-Dunn, Philadelphia.

METALS & PLASTICS

Zinc Alloy Die Castings.....42

New technical department bulletin *Zamac Alloys for Zinc Alloy Die Castings* is published by New Jersey Zinc Co., New York. Described are composition limits, mechanical properties, test methods, corrosion resistance, methods of finishing, machining, assembling of castings, and other technical data.

Plastic Tubing 43

New illustrated catalog from Irving Varnish and Insulator Co., Irvington, N. J., describes company's fibronized extruded plastic tubing, its characteristics, and applications.

Resin Plasticizer 44

New bulletin describes Paraplex G-25 developed by Resinous Products & Chemical Co., Philadelphia. This plasticizer is reported resistant to oils, gasoline, and heat, also as showing promise in polyvinyl chloride cable compounds and cable lacquers, wire enamels, vinyl resin fabric coatings, hot-melt compositions, aircraft gaskets and caulking and sealing compounds. Product is a saturated polyester, thermo-plastic and chemically stable, and it can be used for all polyvinyl chloride resins and elastomers of the acrylonitrile butadiene type states maker.

Polyvinyl Resins 45

Folder issued by the chemical division of B. F. Goodrich Co., Akron, describes group of resins and plastics recently developed under trade name Geon. Two resins are special polymers of vinyl chloride stated to be marked for their thermal and light stability, toughness, and general inertness. Others are vinyl chloride—Vinylidene chloride co-polymers which combine solubility and thermoplasticity with stability, chemical resistance, and wide useful temperature range. Geon plastics are also described, and given is a partial list of applications.

Thermostatic Bi-Metals 46

Callite Tungsten Corp., Union City, N. J., has issued new technical bulletin on thermostatic bi-metals. "Calliflex" bi-metal is used as a temperature responsive element in automatic control and is available in five types, according to requirements. Given is data on deflection, power of various types in strip and coil, and sizes.

Steel Mold for Plastics 47

Shaping Tomorrow Today describes methods of design and manufacture of steel molds for plastics and die cast metals used by Midland Die & Engraving Co., Chicago. Pointed out is importance of mold in quality of finished product.

MANAGEMENT & EMPLOYEES

On Scheduling Shipments 48

Materials and Scheduling Office of War Production Board has issued *Scheduling Primer*, which describes proper procedure in scheduling shipments from plant.

New Products Check Chart.....49

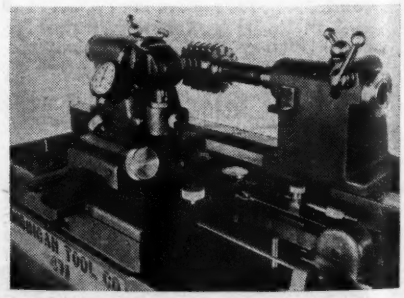
New Products Check Chart, developed by Designers For Industry, Cleveland, for use of manufacturers engaged in postwar planning, provides means of appraising new products being considered for manufacture.

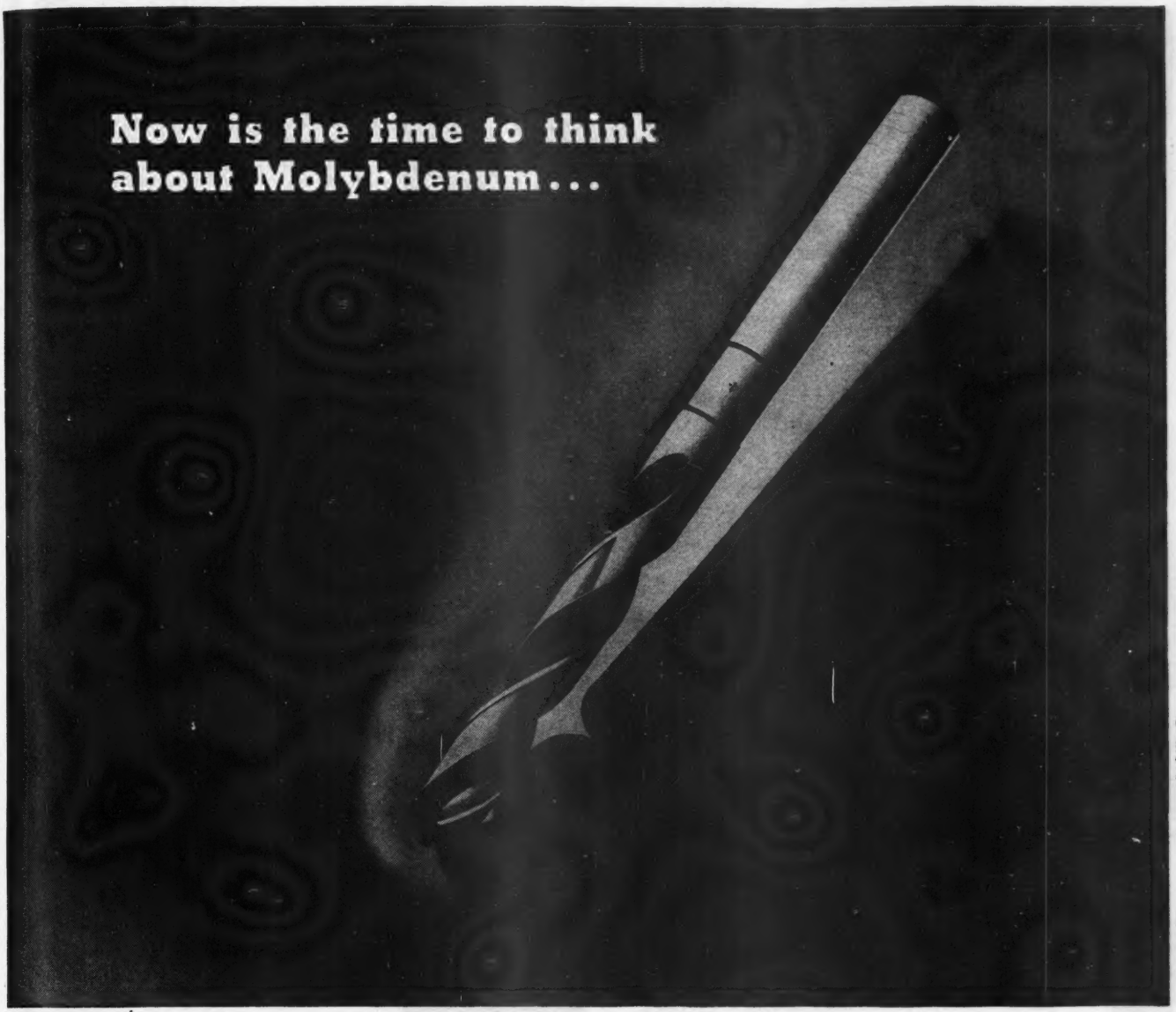
NEW PRODUCTS

Latest Machine Tools

Hob and Milling Cutter Checker

To completely check correct re-sharpening of hobs and milling cutters, a new machine has been developed by **Michigan Tool Co.**, Detroit. Hobs or cutters with max. o. d. of 10 in. and max. length of 8 in., arbor or shaft length max. 16 in., may be checked for spacing of flutes—either parallel or spiral gash—rake angle of flutes, parallelism of straight flutes, taper on o. d., and concentricity of proof dia. by means of two standard interchangeable indicator assemblies. Two additional assemblies are available for checking lead of hob or spacing of threads in multiple thread hobs, measured in a plane parallel to axis, also for checking depth of tooth of toppling hob. To simplify setting of indicators for checking rate angle, parallelism, etc., a ground surface block, top edge of which is in same horizontal plane as headstock and tailstock centers, and projecting ledge in a parallel plane, is mounted on tailstock and used for initial settings. Projecting ledge is used with "Jo" blocks to set indicator for checking hooked or raked hobs. Initial settings are accomplished by rolling indicator opposite ground surface block and adjusting vertical setting of indicator. "Jo" blocks may be placed so that any desird setting may be obtained on, above or below center. After initial setting, indicator base is returned opposite tool for checking sharpening inaccuracies. In or out movement of indicator base is provided by hand operated gearing, a knurled locking screw holding this at any desired position. Cut shows checker checking rake angle and parallelism of hob after sharpening.—**AVIATION, June '44.**





With both molybdenum and tungsten again available for use in high speed steel, consideration of their comparative performance is timely.

Before the war, a careful recording of comparative tests converted many users and tool makers to molybdenum high speed steel. During the tungsten shortage, when use of a high percentage of molybdenum types became mandatory, most users could not watch the performance of their tools carefully enough to draw conclusions on their respective merits.

Reports from large tool producers and users confirm that molybdenum high speed steels, when properly heat treated, perform at least as well under different kinds of shop conditions as the tungsten types which they replace.

Given equal performance on any particular type of work, an investigation of the saving in machining cost effected by molybdenum steels will prove well worth while.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

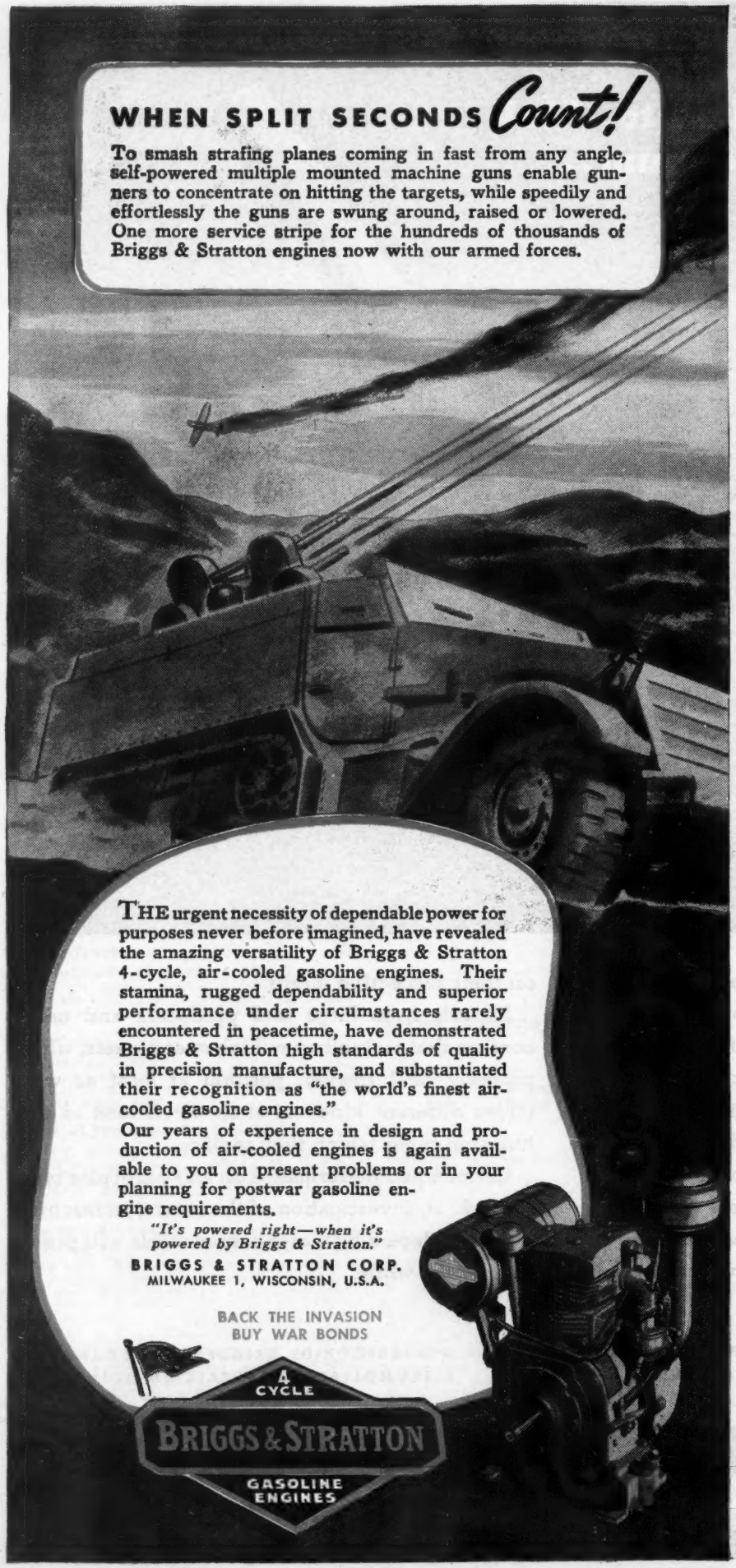
ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

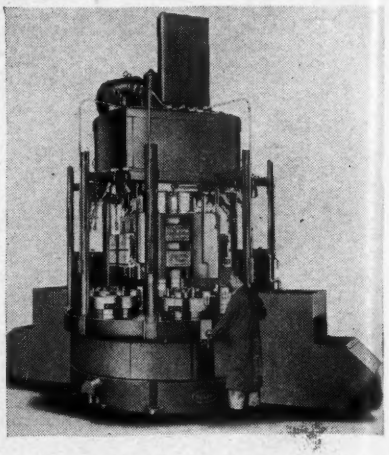
500 Fifth Avenue • New York City

MOLY


WHEN SPLIT SECONDS Count!
To smash strafing planes coming in fast from any angle, self-powered multiple mounted machine guns enable gunners to concentrate on hitting the targets, while speedily and effortlessly the guns are swung around, raised or lowered. One more service stripe for the hundreds of thousands of Briggs & Stratton engines now with our armed forces.
THE urgent necessity of dependable power for purposes never before imagined, have revealed the amazing versatility of Briggs & Stratton 4-cycle, air-cooled gasoline engines. Their stamina, rugged dependability and superior performance under circumstances rarely encountered in peacetime, have demonstrated Briggs & Stratton high standards of quality in precision manufacture, and substantiated their recognition as "the world's finest air-cooled gasoline engines."
Our years of experience in design and production of air-cooled engines is again available to you on present problems or in your planning for postwar gasoline engine requirements.
"It's powered right—when it's powered by Briggs & Stratton."
BRIGGS & STRATTON CORP.
MILWAUKEE 1, WISCONSIN, U.S.A.
BACK THE INVASION
BUY WAR BONDS
4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

"Multi" Processor 51

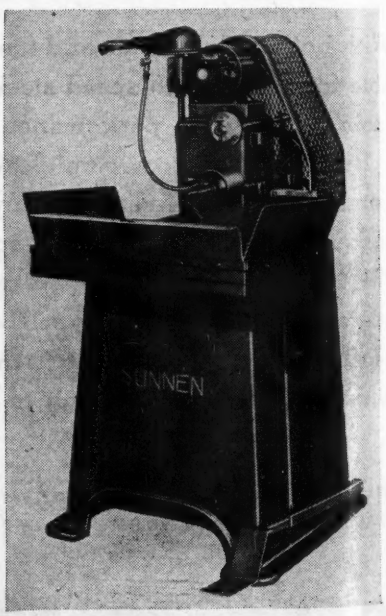
A new and larger "Mult-Au-Matic" designed for operations on component parts of airplane engines, transmissions, etc., is announced by **The Bullard Co.**, Bridgeport, Conn. It machines work up to 34-in. dia. and to 23 in. height. Six heads—two at each working station, each with independent feed works, each providing vertical, horizontal or angular motion—are designed to make possible work of six working stations, with three



stations. All heads are counterweighted hydraulically with an adjustment to give more or less weighting. A specially designed indexing and locking mechanism is to permit smooth indexing and provide rigid positioning and locking of carrier at completion of index. Unit has push button controls, and forward or backward motions are obtainable. An adjustable column carrying tool heads permits moving up and down of all six heads as a unit. Dual speed range gives low speed with more power for heavy cuts, or high speed for smaller diameters. One or two spindles may be in low speed while others are in high range. A fluid motor drive at loading station jogs spindle for targeting and indicating.—**AVIATION, June '44.**

Honing Machine 52

Reporting it to be simple and economical, **Sunnen Products Co.**, St. Louis, announces precision honing machine for sizing and finishing holes in virtually any



metal, also in plastic and ceramic parts. It is said that unskilled workers can produce excellent results on this machine, which can be set up in about one minute for any size from .185 in. to 2.625-in. dia. For sizing and finishing on this machine: Aluminum aircraft links, remote

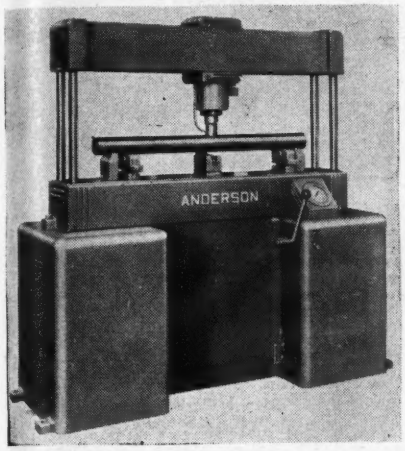
control valve bodies, hydraulic cylinders, many engine parts, valve bushings, carburetor idler valve jets, valve tappet, etc.—**AVIATION, June, '44.**

Heavy Duty Milling Cutter 53

Type "H" is new milling cutter announced by **Lovejoy Tool Co.**, Springfield, Vt. Designed for heavy duty, blades are of 1-in. dia., capable of taking cuts up to ¾ in. Company's locking principle is employed, and blades are interchangeable. Furnished in diameters 6 to 8 in. for shell and arbor mounting, and diameters 9 in. and larger for spindle mounting. Cutters can be furnished with negative cutting angles.—**AVIATION, June '44.**

New Power Press 54

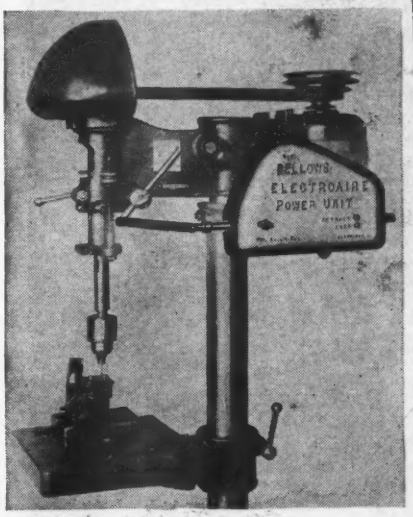
Anderson Brothers Mfg. Co., Rockford, Ill., announced a new power press with traveling ram adaptable for straightening cam shafts. Instead of moving anvils, centers, and work, ram is moved along on ball bearings. Base and hydraulic unit are same as used on Model HP-010-P with sensitive control permitting inch-



ing shaft along a thousandth at a time. First unit has 10-ton capacity. Planned is a 25-ton unit.—**AVIATION, June '44.**

Automatic Tapper Unit 55

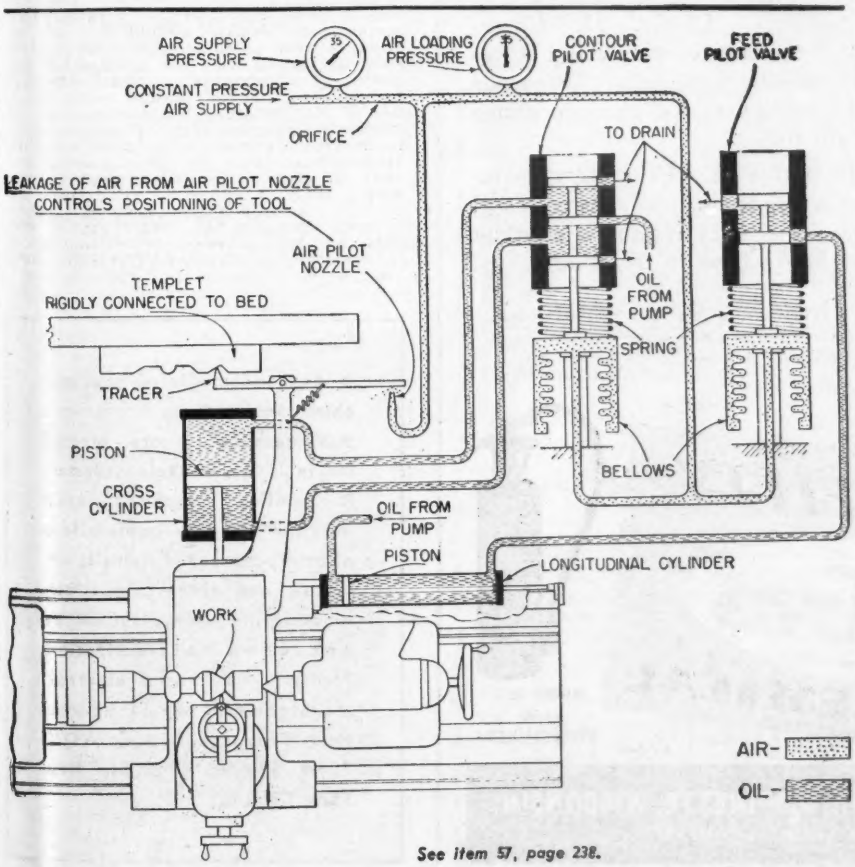
Automatic tapping with precision Class III threads is stated possible on almost any type of drill press with "Electroaire" power feed unit announced by **The Bellows Co.**, Akron. Power feed utilizes a solenoid controlled air motor to advance



and retract spindle. Feed and retraction speeds, independently controlled, are subject to infinite variation. Down feed is held under exact pressure at all times to prevent thread forcing. Same control of reverse feed almost "floats" tap out of piece. Operation is foot controlled. Feed may be synchronized to solenoid controlled jigs, work feeds, and fixtures to make operation automatic. May be set for multi-cycle operation with indexing fixtures and dial feeds. Stroke is adjustable to a maximum of 1¼-in.—**AVIATION, June '44.**

Milling Machine 56

Designed to mill notches on each side of 12 drilled holes in a retained ring, this new machine is equipped with a rotary table which indexes automatically as cutters are retracted vertically upward.



See item 57, page 238.

TENSILE breaking strength as great as 1016 pounds per 2-inch width was observed during laboratory tests of 2″ x 10″ strips (0.375″ to 0.5″ thick) of six different Booth felt types.

Almost any desired combination of qualities ... durability is only one ... are obtainable through the *controlled* manufacture of Booth "prescription" felts and precision die-cutting into mechanical parts. Read Booth's "Technique of Felt Making."

THE BOOTH FELT COMPANY
482 19th Street Brooklyn, N. Y.
745 Sherman Street Chicago, Ill.

APPLICATION CHART AND SAMPLE KIT . . . Contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)

2075

Booth
TRADE MARK

PRECISION CUT FELT PARTS

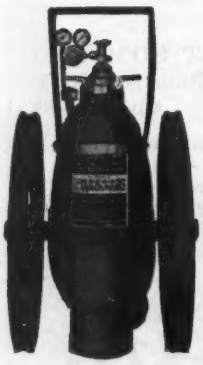
PLUS-FIFTY DUGAS DRY CHEMICAL WILL BE NEEDED HERE... P.D.Q.

Things like this should never happen. But they do—and that's why DUGAS Extinguishers with PLUS-FIFTY DUGAS Dry Chemical should always be within easy reach.

Flammable liquid fires... flammable gas fires...electrical equipment fires *all* yield quickly to the fast fire-killing action of PLUS-FIFTY DUGAS Dry Chemical.

Immediately on striking flames, PLUS-FIFTY DUGAS Dry Chemical releases fire-smothering gases that quickly extinguish dangerous fires. Small fires don't have a chance to get BIG.

PLUS-FIFTY DUGAS Dry Chemical is non-toxic, non-corrosive and non-abrasive. Hurts nothing except fire. For all the facts, write today!



MODEL 150 WHEELED EXTINGUISHER

Approved by Underwriters' Laboratories and Factory Mutual Laboratories.

SEND FOR FREE CHART showing characteristics of all types of approved hand fire extinguishers.

PLUS-FIFTY duGas RED. U. S. PAT. OFF. DRY CHEMICAL

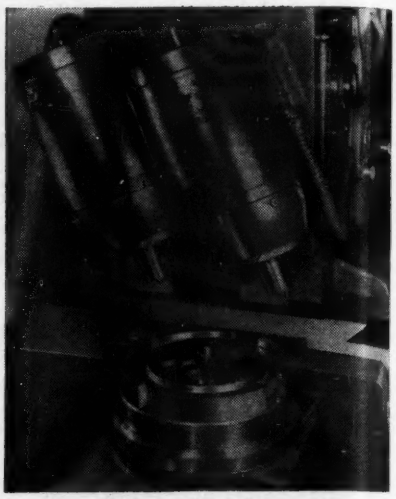
AV-3-44

MODEL 30-T HAND EXTINGUISHER

DUGAS ENGINEERING CORPORATION, MARINETTE, WISCONSIN

OWNED AND OPERATED BY ANSUL CHEMICAL COMPANY

Duplex cutter spindles and slides are mounted in a fixed angular position on a vertical slide. Shell motors are in self contained spindle heads, and cutter spindles serve as motor shafts. Power traverse automatically retracts column to clear rotary table for loading. Work is held in a power clamping fixture, and power traverse moves column forward until cutters are in position. Cam motion reciprocates cutters vertically, synchro-



nizing this motion with automatic indexing on piece. After holes are slotted, cutters move to upward vertical position, and column retracts to loading position, where machine automatically stops. Made by **Cross Co.**, Detroit.—**AVIATION**, June '44.

Contour Control.....57

A new contour control (see p. 237) principle of precision air measuring gage to obtain extreme accuracy in automatic operation of machine tools, has been developed by **Bailey Meter Co.**, Cleveland. Illustrated is application to engine lathe. Unit employs a pneumatic system which scans a thin metal template and controls powerful hydraulic cylinders which position cutting tool or work. Contours may include slow and fast tapers, round corners and square shoulders. All diameters and shoulders of a step shaft may be turned with one setting of tool. Accuracy of contour control is secured by using air control system as an amplifier of motion and a source of power in transmitting movement of tracer stylus to control system. Motion of hydraulic pilot is from 25 to 100 times greater than that of stylus depending upon rate of spring used in hydraulic pilot valve assembly. A fully balanced air pilot valve permits operation of tracer stylus with from 3 to 8 oz. of force, permitting use of soft metal template.—**AVIATION**, June, '44.

• Announcements of new machine tools, shop equipment, and accessories are invited for inclusion in these columns. In writing, emphasis upon aviation industry applications of newly-marketed items is desirable, and wherever possible, glossy-print photos should be enclosed for illustration. Please do not send electros. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City 18.

Shop Equipment & Accessories

Stellite-Tipped Tools 58

Especially designed for machining steel, two new Stellite-tipped tools are announced by **Haynes Stellite Co.**, Kokomo, Ind. They consist of a cutting tip of Stellite 98M2 cobalt-base alloy brazed or butt welded to a tough steel shank, with proper clearance and lead angles ground for turning steel. Tools are recommended by maker for applications employing tools having large cross sections or which are bent or offset, or for tool holders in which solid tool bits are impractical. Tools are also used for forming and grooving operations. They are ground with a 15-deg. and cutting-edge angle, a 15-deg. side cutting-edge angle, a 7-deg. and relief angle, and a 7-deg. side relief angle. They are furnished with flat tops so that side rake angle may be ground for each job.—**AVIATION—June '44.**

Torque Equipment.....59

Zimmerman Products Engineering, North Newington, Conn., presents a complete line of torque equipment. Test stands are used for checking any torque device and to set torque tool to desired torque. Stands are made in two sizes—to 500-in. lb. capacity also to 1,000-in. lb. capacity. Torque tools are made in straight handle types, "T" handle models, torque tapping tools and torque screw drivers.—**AVIATION, June '44.**

Insulation Tester 60

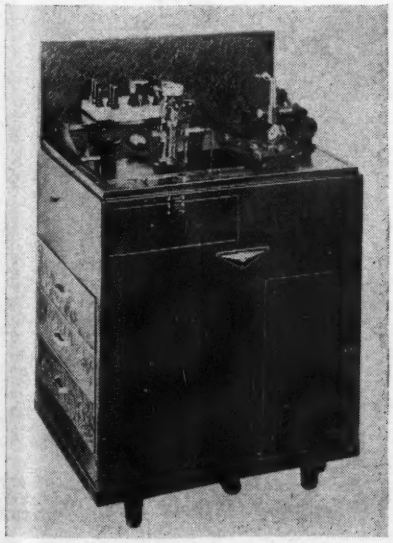
V. T. volt ohmeggor insulation tester made by **Radio City Products,** New York, provides insulation testing at 500 v. up to 10,000,000,000 ohms (10,000 megohms), a comprehensive electronic multitestor and a capacitymeter measuring as low as 0.0000025 mfds. (2.5 micro microfarads), and up to 2,000 mfds. Includes VR 105-30 voltage regulator tube and associated circuits. 13 a. c. and d. c. voltage scales, measuring from a fraction of a volt to 6,000 v. at very high sensitivity. Direct reading with high voltage test leads r.f. lead; signal tracing probe. Vacuum tube voltmeter on all ranges; input resistance 16 megohms max. V. T. ohmmeter, 7 ranges to 1,000 megohms.—**AVIATION, June '44.**

Resin Tape for Plywoods 61

Split or cracked thin veneers used in aircraft may now be salvaged through use of Tego tape, states **Resinous Products & Chemical Co.,** Philadelphia. Weatherproof, it is said that this thermo-setting resin of the phenol-formaldehyde type restores mechanical strength of original veneer without impairing its weather resistance.—**AVIATION, June '44.**

Spark Plug Test Stand.....62

Engineered by **Airplane Mfg. & Supply Co.,** N. Hollywood, Calif., are two new, fully equipped spark plug test stands on wheels for cleaning, adjusting, and testing of mica and ceramic plugs. Both stands contain either a Wheatstone bridge circuit and pressure test bomb for testing or a motor and magneto combination. To determine electrical condition, frequency and quality of spark under simulated engine conditions, a high pressure test chamber is arranged, operating with a CO_2 bottle, taking pressure up to 750 lb. Mica stand provides a motor with shaft for cleaning collet; and on ceramic stand a sand blaster is cleaning agent. Appropriate tools are provided for adjusting electrodes, also a large storage compartment for 432 plugs and a large tool-and-parts drawer are conveniently arranged. Any 110-v. a. c. line provides sufficient power. Mica stand has special built-in vise adjustable to hold plugs at any desired angle, also heating lamps in storage compartment to prevent dampness.—**AVIATION, June '44.**

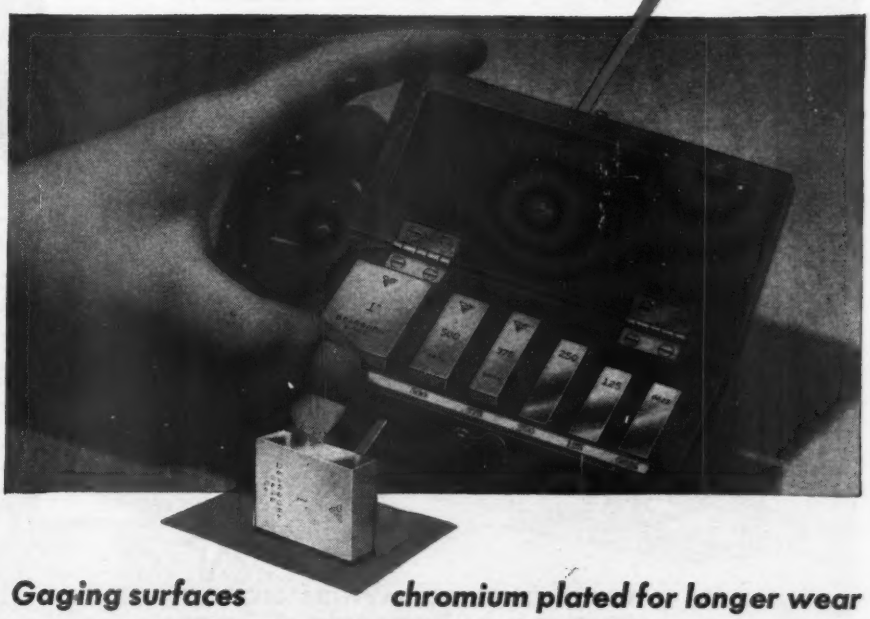


Telephone Type Relay 63

This relay was specifically designed for high frequency use and incorporates Mycalex insulation, but it can be supplied with Bakelite insulation for standard switching service. Coil is cellulose acetate sealed for resistance to humidity and will withstand shock and vibration to 10 G's, states **Allied Control Co.,** New York. Contacts are palladium, fine silver, or special alloys. Double pile-ups of contacts can be supplied from a single "A" (SPSTNO), "B" (SPSTNO) or "C" (SPDT) arrangement to a maximum of four "C" combinations. Weight and dimensions, less contact pile-ups, are 1½ oz. and 1 7/16x15.16x1 $\frac{1}{16}$ in.—**AVIATION, June '44.**

TOOL MAKERS . .

. . here's an Ellstrom gage block set that was made for you

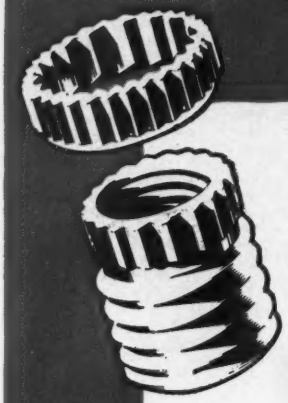


Gaging surfaces *chromium plated for longer wear*

This Ellstrom Tool Makers Set is the first set of its kind to be offered with *chromium plated gaging surfaces* for longer wear. It is a personalized set for those tool makers who want their own individual set of standards for checking purposes. Each set consists of 6 blocks in the following sizes, .0625, .125, .250, .375, .500 and 1" contained in a hand-rubbed walnut case. These Ellstrom sets are available in standard accuracies. Write today for prices and delivery dates.

DEARBORN GAGE CO. 22035 BEECH STREET DEARBORN, MICHIGAN

Originators of Chromium Plated Gage Blocks



Another Use for

ROSÁN
LOCKED-IN
INSERTS

Rosán Threaded Inserts go into each and every SB2C Curtiss Navy Helldiver which rolls from the final assembly line at the Curtiss-Wright Columbus plant, to take part in the widespread offensive against the Japs in the Pacific.

These inserts are installed in the fuselage of these new and deadly dive bombers.

Rosán Fastening Units are locked in the material, so that they will not be turned or loosened by the vibration of the plane, and they provide permanent steel fastening points in the softer metals which are used in aircraft construction.

The fact that they can be easily removed without special tools makes field repairs easy, and effects enormous savings in oversize parts inventory, repair time, and parts salvage.

Manufacturers are invited to submit their fastening problems to our Engineering Department. No obligation.

ROSAN

U. S. and Foreign Pats. Pend.

THIS SB2C CURTISS NAVY HELLDIVER is the latest in the historic series of Curtiss Helldiver dive bombers built specifically for the U. S. Navy. The Navy's new "Fist of the Fleet" can operate from both aircraft carriers and land bases.

ARMY E NAVY

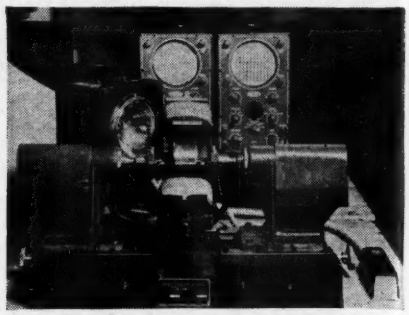
A PRODUCT OF

BARDWELL & McALISTER, INC.

DEPT. 3-64 BOX 1310, HOLLYWOOD 28, CALIF.

Balancing Instruments 64

The dynascopic balancing instruments made by **Bromley Engineering Co.**, Detroit, indicate visually extent and location of forces due to unbalance at any chosen speed, at both sides of rotating body simultaneously. Two 5 in. cathode ray oscilloscopes, one for each end of the rotating body, are used as indicating devices and to transform mechanical vibrations into a visual pattern. By



means of an electrical loading mechanism, a single revolution is impressed on oscilloscope as a straight line. Vibrations of body are impressed on this pattern to draw line into a sine wave, which may be viewed at any speed, thereby defining criticals, dynamatic and static, indicating phase shift between criticals and providing positive means of direct reading at any speed. Electrical equipment has a variable ratio of amplification which allows an extremely small or large amount of unbalance to be accurately measured, states maker.—**AVIATION, June '44.**

Blind Rivets 65

These rivets are designed to make it easier to handle jobs in difficult places offering only one-side access to work. A new feature is a notch in pulling mandrel, serving to inhibit flow of metal in upsetting process and making possible a shorter mandrel. **Cherry Rivet Co.**, Los Angeles.—**AVIATION, June, '44.**

Key Seating Tool 66

Made by **Topflight Tool Co.**, Towson, Md., this key seating tool is especially designed to simplify installation of deicer boot Rivnuts. It replaces broaching process, eliminating burrs, it is said, and

can be regulated to make a seat of any desired depth to accommodate key. Automatic pilot assures accurate placing of seat.—**AVIATION, June '44.**

CRAFTINT DOUBLETONE DRAWING PAPER

Better Drawings • Faster

FOR MANUALS · HANDBOOKS · CATALOGS

For Illustrating

MANUALS
HANDBOOKS
CATALOGS

Link Aviation Devices of Binghamton, N. Y., makers of the famous Link Trainer, are producing some outstanding three-dimensional drawings on Craftint Doubletone. An example of the fine results this company is getting is shown in the accompanying illustration, supplied through the courtesy of Link. Note the clarity of detail and excellent technique.

For real interpretive drawings, mechanically accurate, and showing the object just as the eye sees it, we make the unqualified statement that there is no method superior to the Craftint system. Craftint, with its automatic shading feature, actually is saving up to 85% in man hours in the drafting room.

For other specimens of Craftint Doubletone Drawings, see pages 105 to 115 of the Air Service Command Book—"A. N. Specifications . . . Guide to Proper Preparation of Technical Handbook Art and Manuscript for Army and Navy."

CRAFTINT VELLUM

This fine tracing paper, containing the automatic shading feature, has come into wide use in the Aircraft Industry. Drawings made on Craftint Doubletone Vellum require no hand shading or cross hatching. They are used for direct contact printing, like any other tracing paper. They save countless hours of time, and produce superior results.

There Is No Industry

where mechanical drawings are used, that cannot employ Craftint Doubletone Drawing Paper or Craftint Vellum to advantage.

THE CRAFTINT MANUFACTURING CO.
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CLEVELAND, OHIO

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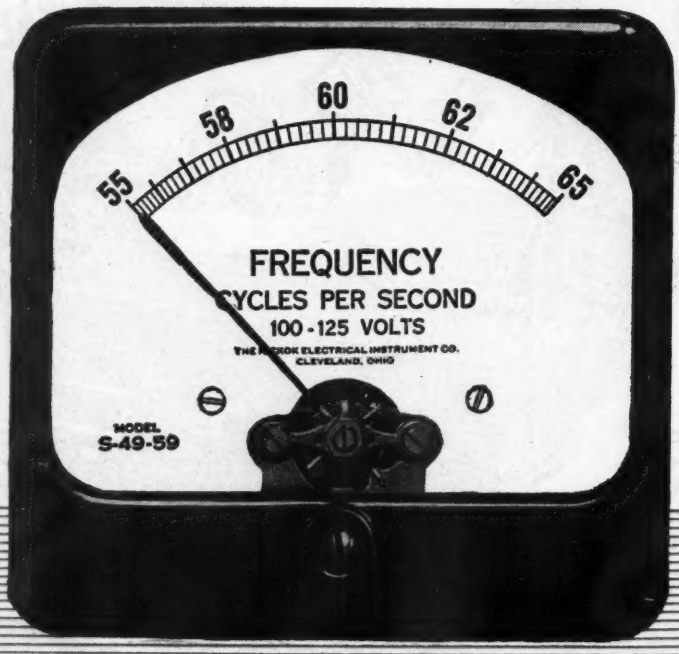

Frequency Meters

HICKOK Frequency Meters are designed with electrodynamometer movements without use of external reactor. Made to operate at an accuracy equivalent to 3/10 of 1% at normal frequency. Used by the Armed Forces of the United Nations for maximum dependability. Model S-49 illustrated, is made for normal operating voltage of 90-140 or 180-280. 4", 5" and 6" sizes. Write today for your copy of new meter catalog ready soon.

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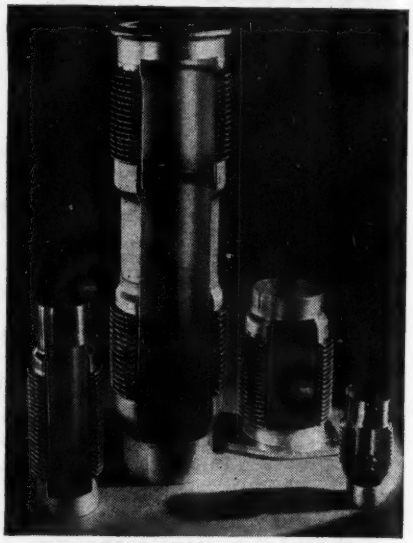
THE STANDARD OF QUALITY FOR A THIRD OF A CENTURY

Bantam Motors 67

Fractional hp. motors, for installations requiring maximum power per ounce of weight, are offered by **Small Motors**, Chicago. SM-2 models are completely enclosed with aluminum ends, ball bearings, and stainless steel shafts. Speeds are from 2,000 to 20,000 rpm., reversible, with high starting torque and low current draw. Voltages from 6 to 230. Built to users' precise specifications.—**AVIATION, June, '44.**

Exhaust Heater 68

Chicago Metal Hose Corp., Maywood, Ill., offers various types of stainless steel flexible assemblies for aircraft use. Unit



illustrated is gasoline engine exhaust heater assembly, which is 2-in. i.d. Rex-Flex close-pitch stainless steel flexible assembly with liner and special and adapter electrical-resistance welded to flexible segment. Liner is designed to prevent flame impingement on light flexible section of wall. Unit is for high temperature aircraft exhaust.—**AVIATION, June '44.**

Selector Valve 69

Designed for aircraft installations, such as bomb bay doors, landing gear, wing flaps, etc., **Adel Precision Products Corp.**, Burbank, Calif., announces a new solenoid operated 4-way hydraulic selector valve reported of light weight, greatly accelerated action, and low current consumption. Valve measures 2⅝ x 2⅞ x 7 3/16 in. and weighs 4.1 lb. Current of 12 amp. at moment of impulse automatically drops at completion of stroke to holding pull of only 0.2 amp. at 24-v.dc. Operates at pressures up to 1,500 psi.—**AVIATION, June, '44.**

Multiple Potentiometer 70

In this new multiple control, operable either as a rheostate or multiple potentiometer, a number of contactors roll upon a single resistance coil. Each of contactors is in form of a twisted bar and is insulated from other contactors to engage successive convolutions of coil to permit accurate control of current supplied without influencing current delivered by any of other contactors. Unit fits into space heretofore required for single unit of conventional design with very little increase in weight. **American Pattern & Mfg. Co.**, Detroit.—**AVIATION, June, '44.**

Pneumatic Filing Machine 71

For fine finish filing on die casting dies, plastic molds, and aircraft parts, **Keller Tool Co.**, Grand Haven, Mich., has designed a pneumatic hand filer which may also be used as a portable power saw for making irregular saw cuts. This new tool includes rotary air motor with a new cam and piston using a ball bearing assembly to transfer rotary motion of motor to reciprocating motion of file. Air operated, it is stated to be cool and comfortable to handle under heavy load. Made in one size with a free speed rating

of 1,500 strokes per minute and fixed length of file stroke of 7/16 in.—**AVIATION, June '44.**

Aircraft Testing Manometer.....72

For measuring surface pressures on aircraft being wind-tunnel tested, a special portable manometer has been designed by **Trimount Instrument Co.**, Chicago. Device consists of ten banks of six tubes each with every sixth tube being atmospheric. Scales are made of glass with black opaque increments and numerals. Any type of indicating fluid may be used. Wells are automatically positioned throughout full range of manometer by means of electric motors. Backlighting which prevents reflection of glare makes it possible to photograph readings for permanent records. Fluorescent lights illuminate scales for visual reading. Instrument is also used for studying intercoolers and aftercoolers.—**AVIATION, June '44.**

Taper Chuck.....73

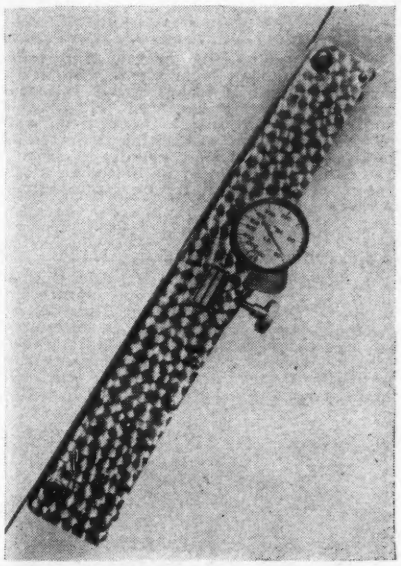
Performance of radial arm routers, widely used for high speed production of nonferrous flat sheet parts, is reported improved by use of inverted taper friction chuck. Taper chuck is sesired to counteract effects of side thrust developed by cutting pressure. Features of precision machine taper of chuck and bit shank are to assure perfect axial alignment and proper centering of tool. Bit slippage cannot occur because of spring and pin unit. "Whip" of router bit is also eliminated, it is stated. Patented by **Onsrud Machine Works**, Chicago.—**AVIATION, June, '44.**

Tail Wheel Assembly.....74

Operating automatically, and combining steerable and full swivel features, a new tail wheel assembly for light planes is announced by **Scott Aviation Co.**, Lancaster, N. Y. Advantages reported by maker are: Greater ease in ground handling, ship may be pushed backwards or tail sideways without strain, sharper taxiing turns can be made, and there is effective control in strong cross winds.—**AVIATION, June '44.**

Cable Tension Meter.....75

Goodyear Aircraft Corp., Akron, states this improved cable tension meter combines lightness with strength. Cable running length-wise through meter is deviated from its straight course within meter. Force required to bend cable is proportionate in exact ratio to tension in cable itself, and this tension is registered on dial. Incorporated is a compensating

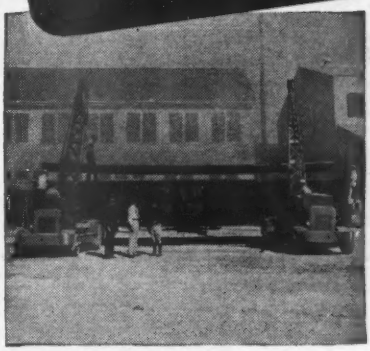


device which adjusts itself automatically to each size and stiffness of wire measure. Has maximum range of 3,000 lb. on cables up to 7/18 in.—**AVIATION, June '44.**

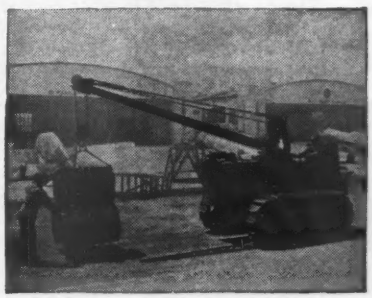
Center Lapping Points.....76

For close tolerances in thread grinding and o. d. grinding, **Bay State Abrasive**

Free-Roving Tractor-Footed
ROUSTABOUT CRANE



• Twin Roustabout Cranes unload extra-long strip steel.



•Roustabout Crane hustles gasoline drums at an airport.

Speedy Load-Handling
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• Its speedy on-the-spot load-hustling makes the Roustabout Crane invaluable to the hundreds of airports, factories, railroads, docks and warehouses that now have one or more. On wheels or crawler tracks, it goes anywhere, loads, unloads, stacks anything to five tons, prevents costly delays. Easy to operate, all tractor power, ball-bearing boom turntable, gears in oil, full boom swing—built for years of overwork. It fills the gap in your post-war materials handling plans. Write today for the cost-saving facts.

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The Sweetest "PORK CHOP" Angle Drill You Ever Saw

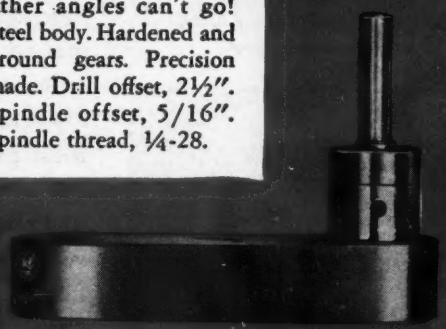
Look it over... it's the last word in design for this type of drill. The ribbed body is die cast with oilless type thrust and radial bearings. Enclosed bevel gear drive. Drive shaft and spindle are precision ground and heat treated. This drill wears long and well. Spindle offset, 9/32"; standard spindle thread, ¼-28 (10-32 optional). Order a trial quantity.

Drills shown ¾ actual size.

Try a few of these in your plant - see what they do on the job →

And a Tough, Long-Wearing FLAT OFFSET DRILL

This drill moves in where other angles can't go! Steel body. Hardened and ground gears. Precision made. Drill offset, 2½". Spindle offset, 5/16". Spindle thread, ¼-28.



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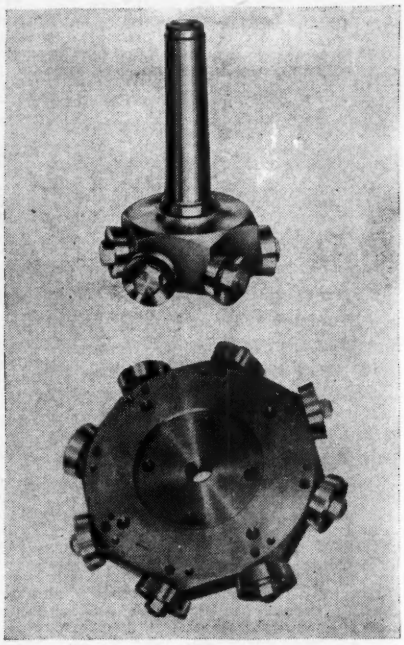
609 Stephenson Bldg., Detroit 2, Mich.

Products Co., Westboro, Mass., has developed "Blue Flash" center lapping points for use on Ex-Cell-O center lapping machines. Made in blank form, then shaped, trued and sized after mounting, it is stated that finished product is sharp, smooth-running, with no hard or soft spots.—**AVIATION, June '44.**

Milling Cutters 77

Shearcut milling cutters have cutting bits which present circular cutting edges in a knife-like manner to remove metal in a true shearing action. When a cutting edge of unit is dulled, simple rotation of



cutter a fraction of an inch, without removal from machine, is stated to bring new, sharp cutting edge to bear. Each unit has from 10 to 30 cutting edges, depending on diameter. States maker: In removing a curled chip like a lathe tool, cutter usually leaves a finish without tool marks, often eliminating grinding or polishing. Cutter may be rotated in either direction. Manufacturer is **Shearcut Tool Co.**, Beverly Hills, Calif.—**AVIATION, June, '44.**

Wet Grinder 78

New wet grinder being offered by **Boice-Crane Co.**, Toledo, has a true, concentric-running 10-in. Berea-quarried sandstone wheel, accurately centered on its arbor so as to grind a straight bevel from wheel to edge without weakening tool temper. Designed for proper grinding speed of 120 rpm., grinder may be belted to a 1,750 rpm. motor, lineshaft, or gas engine.—**AVIATION, June '44.**

Adjustable Countersink 79

Among features reported for this adjustable micrometer stop countersink, made by **Schrillo Aero Tool Eng. Co.**, Los Angeles, are: adjustments in increments of .001-in. without use of tool; positive lock, preventing loss of adjustments while in use; self contained knockout pin, facilitating removal of taper shank cutters;

ball thrust bearing; self lubricating long life bearing; and hardened and ground alloy steel shaft.—**AVIATION, June '44.**

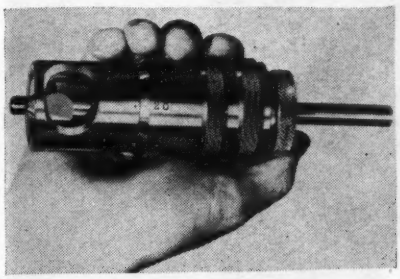
Model-Plane Motor 80

For wind tunnel test use in model planes, **General Electric Co.**, Schenectady,

N. Y., announces a new engine measuring 5 x 18 in., rated at 30 hp. and weighing 57 lb. Rated speed is 6,000 rpm., but it can operate in excess of 7,500 rpm. Water cooled.—**AVIATION, June, '44.**

Large Micrometer Countersink 81

This new tool countersinks up to 1¼ in. and can countersink 12 in. rivets. Can be instantly locked at each setting in



increments of .001, states maker. Adjustments are made manually and while tool is in operation. Includes interchangeable 1-in. dia. cutter, available in 72, 78, 82, 100, 110, and 115-deg. angles with or without integral pilot. Made by **Aero Tool Co.,** Burbank, Calif.— **AVIATION, June '44.**

Carbide-Tipped Tools.....82

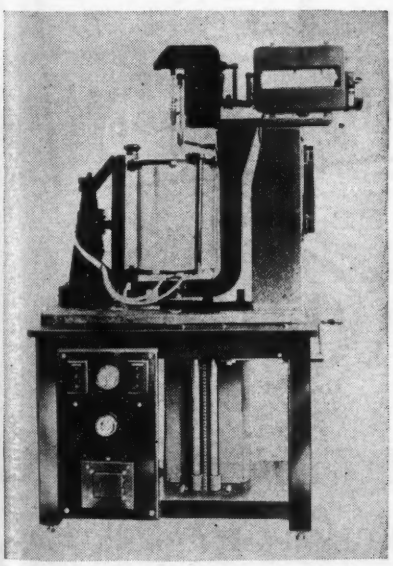
To round out their line, **Jessop Steel Co.,** Washington, Pa., announces "Malta" carbide-tipped tools, made in ten styles in a wide range of sizes and three grades of tips.—**AVIATION, June '44.**

Battery Connectors 83

New development in quick disconnect battery connectors particularly adapted to G-1 standard batteries conforming to AN-W-B-141 specifications is offered by **Cannon Electric Development Co.,** Los Angeles. Based on screw-jack principle, it is stated that this new fitting speeds removal of batteries and banishes shorting and fire hazards. Large hand wheel which turns a gear and disengages battery is notched and easily operated by a gloved hand in sub-zero temperatures. —**AVIATION, June, '44.**

Temperature Recorder.....84

Announced by **The Bristol Co.,** Waterbury, Conn., is a new direct-reading dilatometer which records temperature, dilation changes and temperature, and time changes simultaneously in ink during heating, and cooling cycles of ferrous and non-ferrous metals, ceramics, and many other materials in solid form. Two records are made on a chart with rectangular coordinates for ease of interpretation and filing. Ball bearing multiplying mechanism exerts very light pressure on sample and provides accurate records, it is re-



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What you want most in a capacitor is what you are sure of getting in TOBE Capacitors: . . . *long life!* Your proof is in Tobe's enviable record of practically no "returns". Frequent, rigid inspections eliminate uncertainty. Constant research brings constant improvement. The original capacitor with hold-down bracket, Tobe OM-601, offers many definite advantages. This capacitor is strong, compact and space-saving. The hold-down bracket permits the use of either inverted or upright terminals, with wiring underneath or on top of chassis. Write for details and samples (1.0 mfd and 2.0 mfd). Tobe engineers are glad to be of service.

This new separate mounting is stronger and helps prevent leaks caused by breaks in can. This outstanding Tobe design takes the minimum amount of space.

LONG LIFE ASSURED!

SPECIFICATIONS TOBE OM-601 CAPACITORS

TYPE . . . . . OM
RATINGS .05 to 2.0 mfd. 600 V. D. C.
.05 mfd. to 1.0 mfd. 1,000 V. D. C.
STANDARD CAPACITY TOLERANCE . . . 10%
TEST VOLTAGE . . . Twice D. C. rating
GROUND TEST . . . 2,500 Volts, D. C.
OPERATING TEMPERATURE . . 55°F to 185°F
MOUNTING HOLE CENTERS . . . . . 1½"

SHUNT RESISTANCE
.05 to 0.1 mfd. 20,000 megohms
.25 to 0.5 mfd. 12,000 megohms
1.0 to 2.0 mfd. 12,000 megohms
POWER FACTOR
At 1,000 cycles—.002 to .005
CONTAINER SIZE
Width ⅝", length 1 5/16", ht. 2¼"

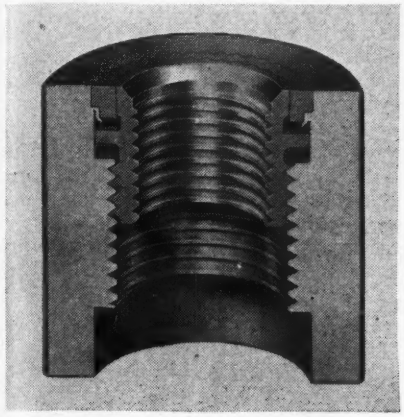
TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

A small part in Victory Today . . **A BIG PART IN INDUSTRY TOMORROW**

ported. Split furnace designed for temperatures to 2,500 deg. F. can be pulled away from sample for quenching or cooling without disturbing record, and inside dimensions allow use of any size shop sample up to 1⅝ in. dia. by 5 in. long. Dilatometer can be used to determine: Critical points of carbon steel, coefficients of expansion of metal, thermal composition of steels, heating rates, and heat saturation.—**AVIATION, June '44.**

Hydraulic Seal Insert 85

This Rosan hydraulic seal insert, product of **Bardwell & McAllister,** Hollywood, Calif., is used for sealing fluid and gas



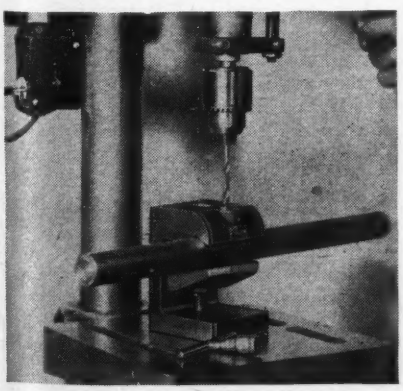
ports under pressure and has tested up to 10,000 lb. It is secured in material by a locking ring, serrated inside and out. Ring engages its inner serrations with teeth of a serrated collar on insert. As ring is driven or pressed into place, its outer splines broach wall of a counterbore and lock unit firmly in parent material. In unit shown, straight external threads are sealed with a synthetic rubber ring. Internal threads are provided with standard "A.N.D." type seal. In case of damage to insert, it may be removed by a simple drilling operation and replaced without disturbing parent material.—**AVIATION, June '44.**

Welder Control 86

Technical Bulletin **No. 75-51-50** from **Weltronic Co.,** Detroit, gives features, specifications and functions of the Weltronic synchronous resistance-welder control, Model 75-51-50. Reported fully automatic, all electronic, precisely synchronous, and continuously adjustable, this model is designed to permit complete control of operations on spot welders using air or hydraulically actuated electrodes, with solenoid operated valves.—**AVIATION, June, '44.**

Work-Holding Vise 87

A new vise embodying an accurate means for cross-center drilling in round or hexagon stock, is announced by **Universal Engineering Co.,** San Diego, Calif. Clamping action of vise is opposed jaw principle, leaving one surface of work clearly exposed for slot milling, etc. All exterior surfaces are precision ground square and parallel allowing vise's use in conjunction with any type of machine tool



as a work holder. There are no moving parts involved in drilling, and bushings through which drills pass are interchangeable, giving a wide range of hole sizes. Bushing boss is jig-bored in alignment with 'V' seat, which is 120-deg. angle for holding either round or hex stock.—**AVIATION, June '44.**

Generator Test Bench 88

For testing generator, regulator, and cut-out on all types of engines, this generator test bench may be operated with or without storage battery. Current output from generator may be varied in 5 amp. steps from 0 to 60 amp. Designed to eliminate taking battery condition into consideration when setting regulator, making possible testing of generator without regulator. Motor is 3 hp. single-phase 220-v. unit with 2-speed winding—900 and 1,800 rpm. It operates in conjunction with a 6-to-1 variable pitch pulley, giving a 12-to-1 speed variation. Manufactured by **Lanagan & Hoke,** Philadelphia.—**AVIATION, June, 44.**

Conveyor-Elevator System 89

Rex Uni-Flo is new type of conveyor, for mass handling of free-flowing bulk materials, made by **Chain Belt Co.,** Milwaukee. With entire cross section of enclosing casing and all space between scraper-carrier flights solidly filled, a continuous flow of material results. Positive discharge mechanism removes all material at point of discharge. It is designed to convey materials horizontally, vertically, or at any angle.—**AVIATION, June, '44.**

Aircraft Instrument Jewels 90

Glass Ring Jewels, developed by **General Electric Co.,** Schenectady, N. Y., for certain of its aircraft instrument bearings, are also available for other applications. Listed in five sizes for use in pre-

LIKE a wild mustang lettin' loose with all he's got, our Navy PT boats lash out at enemy ships, packin' a punch that can knock out the largest battleship afloat.

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Used in machine shops and tool rooms for finishing intricate dies. Used on production lines to clean castings, turnings and forgings . . . sharpen tools and do hundreds of grinding, finishing, polishing, burring, routing and etching operations.

Dremel Moto-Tool has AC-DC motor with shock-proof bakelite housing, oil-sealed (oil-less) bearings, and built in cooling fan. Weighs only 13 ounces—so light and compact a *girl* can handle it with ease. Dynamically balanced armature eliminates vibration and provides precision control. Moto-Tool's high speed (27,000 rpm) permits finer, faster work—conserves cutters.

Dremel Moto-Tools are proving indispensable aids in speeding up war production in such plants as General Electric, Westinghouse, Remington Arms, Ford, Nash-Kelvinator, Consolidated Aircraft, Douglas and Northrup Aircraft, and many similar "Arsenals of Democracy."

Try a Dremel Moto-Tool on your own jobs—in your own shop. See how versatile, how indispensable it is—how it saves time and materials. Order from your distributor or contact a Dremel Representative. PROMPT SHIPMENT on orders with proper priority.

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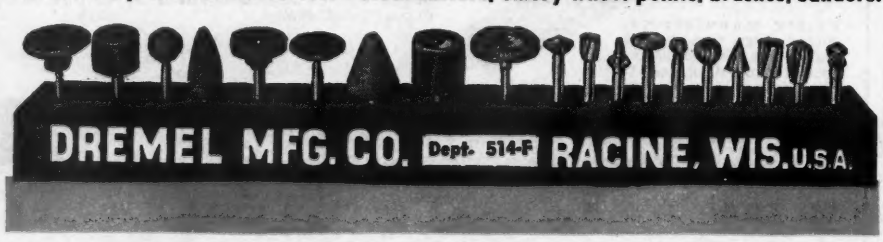
Whether you have a Moto-Tool or any other type of grinder, use only genuine Dremel shop-tested Accessories—steel cutters, emery wheel points, brushes, sanders.



DREMEL MFG. CO. Dept. 514-F RACINE, WIS. U.S.A.

cision measuring equipment, other shapes and sizes are possible for such applications as thread guides, weighing scales, speedometers, etc. Jewels may be press-set or spun into bearing plates and other elements in same manner as sapphire rings.—AVIATION, June, '44.

Forged Cylinder Heads

(*Continued from page* 145)

centrifugal force produced by the high speed cutters would render impossible effective use of fluid coolants, and so the machines were designed to use heavy tallow fed by compressed air in a slotted nozzle through which the edge of the cutter passed. An automatic trip operated the air valve to deliver a "shot" of tallow every few seconds. This was satisfactory in so far as cutting was concerned, but very wasteful of tallow which could not be readily recovered, while the parts, being heavily coated with grease were very objectionable to handle. Experiments are now being conducted with fluid coolants with apparently successful results, and all machines will probably be changed to this in the near future.

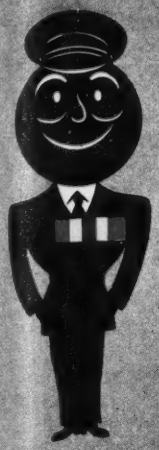
First finning operation consists of cutting 14 fin spaces around lower part of body on a Cincinnati Hydro-Matic with the head mounted on a rotary fixture and located both on the flange and locating pin holes. The grooves are not perfectly circular, nor all of the same contour, and a master cam is used to obtain the necessary rise and fall of the machine spindle. At start of cut, cam follower travels along a horizontal plate to feed cutters in to depth, thereafter it engages cam which rotates at same speed as the part and produces required profile. On this operation two cutters are employed, 0.112 in. thick, and spaced at the mean thickness of the fin which is 0.058-0.068 in. The depth of the cut is about $2\frac{3}{4}$ in. at the deepest part.

Parts are now passed to a Cincinnati Hydro-Tel for cutting 16 fin spaces on the exhaust side. As were all the fin cutting machines, this was built for the particular purpose. It consists essentially of two vertical spindles each carrying single cutter operating at 4,500 fpm., and three rotary tables. One of these carries four identical sets of cams, each being a series of plates whose contours correspond to the varying contours at the base of each individual fin space. The in and out movement of the cutters is controlled hydraulically through a follower wheel held in contact with the cam. The other two tables are work tables each holding four cylinder heads.

Variable speed feed cam controls speed of rotation of parts past the cutters. For the first quarter inch of cut the feed is at the rate of 15 in./min. increasing constantly to a maximum of 70 in. A rapid traverse of 270 in./min. then brings the second head into position, whereupon the feed is slowed again to 15 in. After the fourth head has been cut the rapid traverse is slowed somewhat to allow time for the cam follower to index vertically to the second step of the cam.

A similar machine cuts the five fin spaces on the intake side of the head, after which another similar machine cuts the 38 spaces on the top.

trace THIS FIGHTER'S RECORD BY HIS MEDALS!



"Captain Dag"

If there were decorations for industrial heroes, Mr. Dag would be a much be-ribboned gentleman. Perhaps we should call him 'Captain' Dag, because he commands so versatile a company of physical and chemical properties. Captain Dag (a campaigner who will never be mustered out) represents Dag brand colloidal graphite, the smooth, black liquid concentrate which serves so many different war industries. Capt. Dag may take the form of a dry film, a fluid film, a surface coating, an impregnation, etc.

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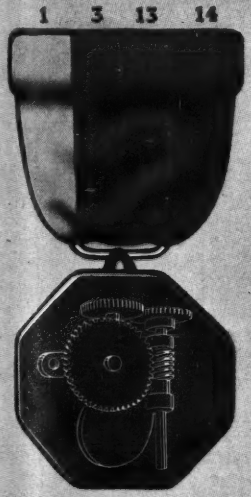
2. Conducts Electricity
3. Withstands Temperature Extremes
4. Absorbs, Radiates and Conducts Heat
5. Maximum Purity
6. Low Coefficient of Expansion
7. Particles Bear Like Electric Charges
8. Insoluble in Acids and Alkalies
9. Black and Opaque
10. Gas Adsorbent
11. Little Photoelectric Effect
12. Miscible with Most Fluids
13. Films Adhere Tenaciously and Dry with Sharp Edges
14. Microscopically Fine Particles. Penetrates
15. An Excellent Suspension

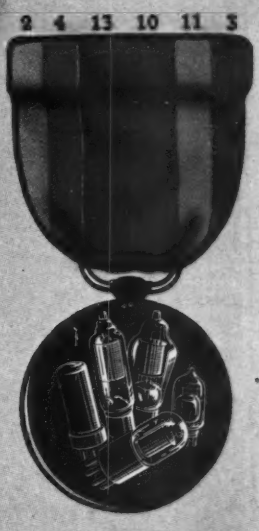
1, 3, 8, 14, 13, 6

CITATION: "We have been enthusiastic users of Dag colloidal graphite for more than ten years. We find it the only material which will prevent bolts, nuts and flanges from seizing under the high temperature and pressure conditions in our boilers and steam systems."



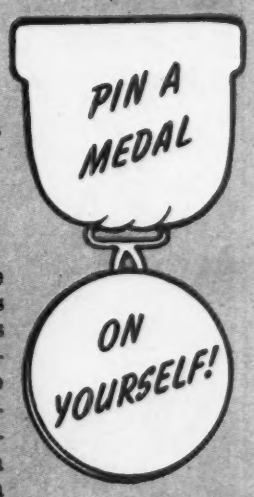
1, 3, 13, 14

CITATION: "Dry films formed from Dag colloidal graphite supply durable lubrication on parts which could not be effectively lubricated otherwise. Such films are functioning at temperatures from (—60° F. to +1200° F.) and higher."



2, 4, 13, 10, 11, 3

CITATION: "Graphite films when applied to the grids (and frequently the plates) of radio tubes for receiving and transmitting, are useful for minimizing secondary emission, 'back' emission and photoelectric effects."



For easy reference we've given colors to Captain Dag's most valuable properties. Match these colors with the performance "citations" above. Then pin a medal on yourself for putting Captain Dag to work in your plant. He's one campaigner who won't be mustered out.

Dag, Oildag, Aquadag, Castordag, Glydag and Prodag are registered trade marks of Acheson Colloids Corporation. Copr. 1944 by Acheson Colloids Corp.

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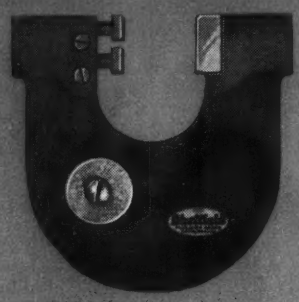
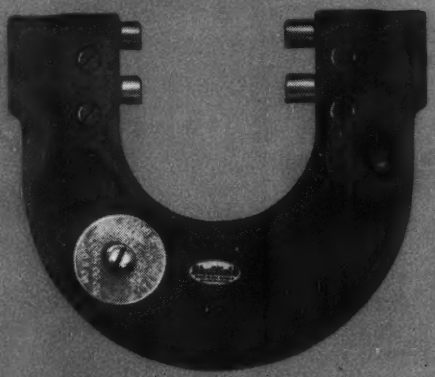
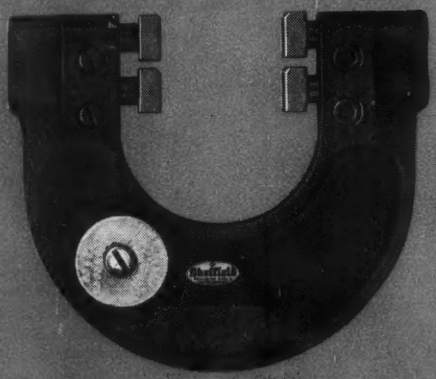


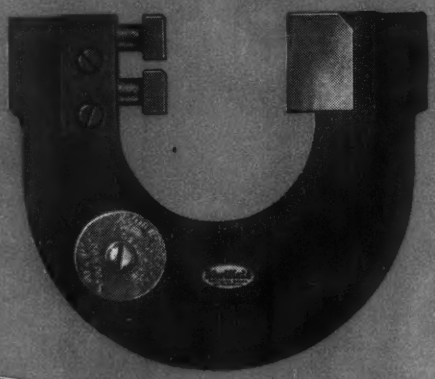
AGD MODEL SMC



AGD MODEL A



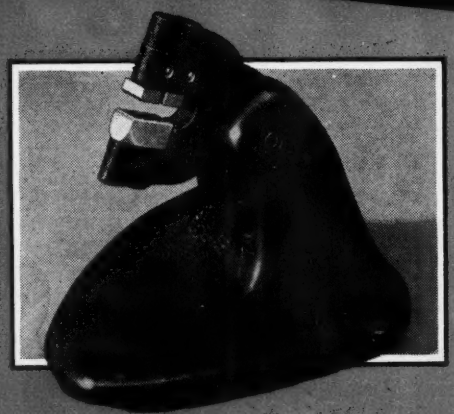
AGD MODEL SB



AGD MODEL SC

HOW TO ORDER

State Frame Model and Frame Size. Stipulate whether gage is to be set and sealed. Give complete marking instructions if set and sealed. For specifications see Sheffield Handbook No. 42-2, pages 150-153.



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Following these operations parts are washed and fully inspected and forwarded to a second Greenlee transfer machine. This comprises a total of 124 stations, divided into three sections, and is similar to the machine used earlier. It performs all semi-finish and finish milling operations, drills, reams, countersinks, and taps all holes, counterbores valve spring seats, finish reams valve guide holes, and forms and taps valve seat counterbores, using carbide tipped taps.

Snyder milling machine is employed for forming counterbores and blending radii inside both bosses in each rocker box. Double ended cutters carry a groove around their periphery to act as a journal, and are supported in bronze brackets. After the head has been located and clamped these brackets advance into position between the bosses, and the driving arbors are advanced manually through the rocker shaft holes to engage the cutters. From there on, the cycle is automatic, the cutters feeding to the right to form one counterbore, then to the left to form the other, and finally returning to the center to permit disengaging of the arbors and withdrawal of the support brackets.

The head is now loaded into a Hall Planetary Mill with a lead screw lock. On this machine a recess is cut at end of thread diameter and at junction of pilot diameter with dome inside head. A second machine then rough and finish mills the special modified buttress thread and the pilot diameter simultaneously, using a combination cutter to assure perfect concentricity.

Final operation consists of turning and facing flange on a Bullard Mult-Au-Matic, part being held on adapter located on buttress thread.

Except fin cutting operations and machining rocker boxes and valve ports, operations are similar to those on cast head, although automatic equipment is employed to a far greater extent than before. Machining time is considerably longer than on cast head, but is more than offset by savings by elimination of lengthy and tedious foundry operations.

Are Stock Values Real?

(*Continued from page* 185)

cut of more than $330,000 annually. No wonder C & S has petitioned the CAB for restoration of its old rate.

Some trade officials look for a period of deficits for the smaller lines after the war; others even maintain that mail rates must be raised in certain cases if, indeed, a few of these lines are to survive. It may be, of course, that the franchise values of new routes that various lines will receive in the next few years will offset the red ink on earnings statements. If such is the case, stock prices of those lines with doubtful earning power may not suffer much.

Two fundamental economic characteristics of the air transport industry are acknowledged to be the high revenue-producing power of the airplane (said to be around $650,000 per plane in 1943) and the relatively low investment in property. But there may have to be some early postwar revision here. We have already stressed the probable decline ahead in payloads. At the same time the investment in flying equipment is apt to rise. Most of the planes the airlines now use were built on the basis of prewar labor costs. Today, of course, labor costs have soared far and away above 1939-41 levels, and it appears to be national policy to maintain labor wage gains as long as possible after the war.

Then the day of transport standardization, as it has been known since 1936 with the Douglas DC-3, may soon be over for the large lines. They haven't had much experience with the big super-liners, and it may take a whale of a lot of adjusting to get operating costs and expenses in line. As a matter of fact, in these days of priority traffic, expenses have got out of hand already. And the coming growth in air transport networks, to which everyone is looking forward, may present such operating difficulties that the new routes will be a drain on earning power in the initial days of their operation.

Peacetime traffic increases will come in the passenger end of the business. Trade observers are far from being in accord on what passenger volume to expect directly after the war. Some point to the returning soldiers who will hasten home by air after their discharge. Others are mindful of the fact that government travel will quickly dry up. At any rate, airline operators generally do not share the optimism of those who predict that passenger air travel can be brought down to bus or rail coach levels. They are wondering about living costs, taxes, also equipment costs in relation to the fares they can charge and still keep in the black.

Nor do they feel that a tremendous growth in cargo traffic is just around the corner. The railroads depended upon passenger traffic for several decades for their bread and butter before freight traffic brought in their best earning power. And despite the reluctant express rate reduction of a year ago, these rates still average 70c. a ton-mile as against 4c. for less-than-carload freight.

Ralph S. Damon, vice president and general manager of American Airlines, sees little on the horizon to indicate that the airlines will carry more than the perishables, specialties, samples, and emergency items where time saved can offset higher transport costs.

Leonard P. Ayres, well known economist of the Cleveland Trust Co., recently concluded (from a survey of airborne transportation covering 800 shippers) that "airlines probably will find it difficult to maintain express traffic at present volumes after the government ceases paying shipping charges on a large portion of it."

Results of the Ayres survey indicate: That the majority of these shippers will use air freight or air express after the war; that present service is highly satisfactory, except for the expense; that cost is uppermost in the minds of shippers; and that all of them will seek the cheapest means of transportation in the postwar period. It was found that the prime

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reason for shipment by air generally was the speeding up of production of war goods rather than the distribution of finished products.

All these factors in the outlook have been mentioned so that the airline investor will realize that these stocks, on the basis of present market prices, are discounting future prospects that may still be quite remote.

There has been no attempt to "bear" the airlines. They are one of the best examples of a growth industry. And there is plenty of romance in their post-war expansion if the stockholder is willing to be reasonably patient. Already it seems clear that with the development of efficient large-scale operation and proper ground handling the airlines will become big business in the next dozen years. And perhaps their most important asset today, though an intangible one to the investor, is the nearly-a-generation of experience that has been telescoped into three short years.

But don't expect the airlines to start cutting any dividend melons or exhibiting the stability of a General Motors Corp. or a United States Steel Corp. directly after the war. The airline investor had best take middle ground between the enthusiastic optimism of an airline traffic manager and the more cautious approach of an operating official.

Forming Sheet Aluminum

(*Continued from page* 159)

neck of the spun shell. It saves time where it can be used but does not allow spinning near the bottom. If an off-center chuck is used, the bottom of drawn shells may first be formed by means of a bulging operation.

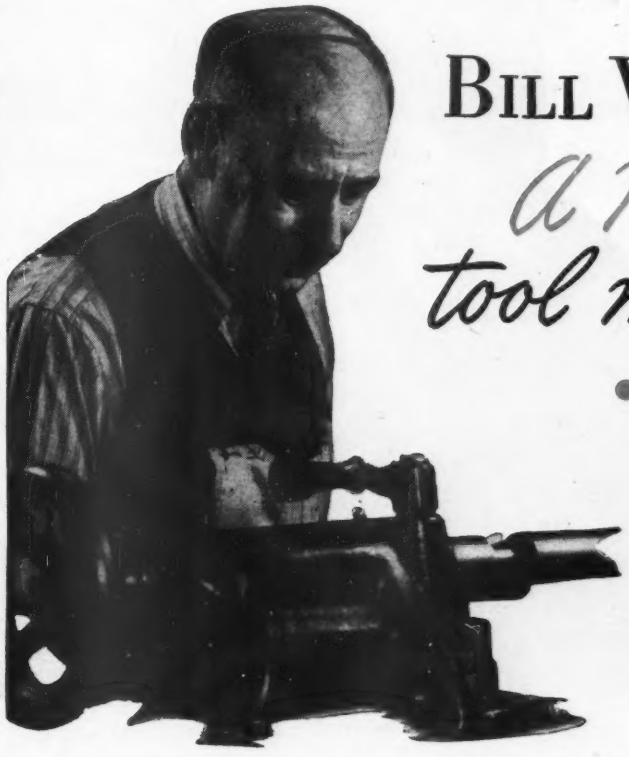
Chucks for spinning are made of aluminum alloy, steel, cast iron, or hardwood, depending on the number of pieces to be spun, their size, shape, and desired finish. For quantity and quality production, the metal chuck is preferable, especially where sharp re-entrant angles are present. Hardened steel chucks with a high polish produce smooth surfaces and are most economical for products that are buffed or given a similar finish. Extremely large pieces are usually spun on wood chucks because of the economy of producing them. They can be cheaply built with laminations so that the contour is readily changed. Chucks should be wear-resistant and kept highly polished as the slightest imperfection in their contour will show up in the work.

The number of tools employed for spinning depends entirely on the operator and cannot be standardized. Each craftsman is apt to develop a set that he likes best; some require a large number of tools while others use a minimum number of three. Tools can be divided into three main classifications: (1) Those for laying the metal down against the chuck; (2) those for beading; and (3) those for cutting or trimming.

A plain, flat, smoothly polished hickory stick with rounded end, is generally used by hand-spinners for breaking down the circular blanks. The half-round all-purpose steel tool may also be used to lay the metal down against the chuck. It is usually described as being half-round on the top side and flat on the bottom, but this is not exactly correct. The upper part of the tool conforms to the description, but the bottom is crowned rather than flat. The upper part of the crown is used to lay down the metal, while the under-side of the crown is used for planishing.

The beading tools are usually either the wheel type or sharpnosed tools, and they are used to roll over or finish the edge of the shell. A plain diamond-shaped tool is used for cutting or trimming any excess metal. Generally, the tools are made of high-carbon steel, forged to shape, hardened, polished, and fastened in a hardwood handle. Where the shell is unusually large or the thickness of the metal is greater than approximately 0.081 in., the spinning tools are mechanically supported and forced against the work. Spinners' tools should be kept smooth and bright if they are to give good performance. They should be buffed lightly, any time they start to drag, and touched with light oil.

The proper blank diameter is found by selecting a circle whose area is equal to the surface area of the spun article. Allowances must be made in both gage and



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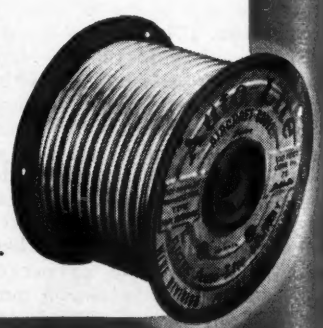

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diameter, however, since the finished article will be slightly thinner than the starting blank. This thinning of the metal results in an increase in area, which is enough to allow for the necessary trimming. The thinning of the metal can be minimized by using several breakdown operations.

Having discussed the best grades of metal to use, methods of annealing, proper tools, ways to lubricate, and correct lathe speeds, it is now possible to go through a simple spinning operation step by step. The first task is centering of the blank, which is put in the lathe as nearly centered as possible and clamped. A flat stick is held lightly against the edge of the blank, the tail stock loosened slightly, and the lathe started. (If the blank is too loose it will fly out; and if too tight, the edge will be marred.) The blank may be centered by pressing lightly against the edge, and as soon as it is in place, the tail stock is tightened. Centering on the chuck can also be accomplished in other ways, such as drilling a hole in the center of the blank or by forming a dimple at the center.

Lubricant is now applied with a dauber. With the hickory stick the blank is laid back against the chuck an inch or so to "set" it. This gives an extra grip to hold the piece in place, and in progressive steps the metal is worked down on the chuck. It is better to start with a slow lathe speed rather than one too fast. If the speed is too great, centrifugal force will make the blank stand out from the chuck, and so much tool pressure will be required that excessive thinning or possibly rupture will result. After again lubricating the laid-back blank, the half-round tool is used to work back over the contour of the chuck from the tail block.

The contact point of the tool should touch the work a little below the center. Steady control is maintained by placing the tool on the tool rest, bracing it against the fulcrum pin to obtain leverage, and gripping it with the free hand. If the tool remains in one place too long it will cut a ring in the surafce. On the other hand, moving it too fast will produce ridges. Working the tool continuously from the center out will thin the metal to the breaking point so it is best to work the tool back and forth in a very short radius, with the arc being not more than an inch or two on either side of the pin. The pin should be moved frequently and the tool kept at right angles to the point of contact.

The whole body is used to apply the tool to the work, not just the arm. Experience is the only way of learning the right amount of body pressure; too much pressure will wrinkle the metal or cause the tool to break through. As stated, the skilled operator feels the metal "flow" under the tool and is able to detect any wobble if the work gets out-of-balance. Annealing will improve the metal's workability if it becomes too hard to flow properly.

A narrow flange is left on the outside of the shell at all times, even up to the final trimming operation. The flange should be kept headed in the same direction as the metal is being worked or it

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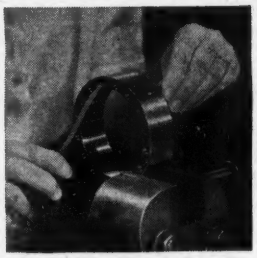

Oil holes in airplane piston heads would classify as inaccessible to effective finishing by old methods, but as the above picture indicates, with Elek-Tro-Cut Three-M-ite Cloth Spiral Wound Strips these holes are finished with speed and the utmost ease. Grooves, threads and flutings also present tough finishing problems. But when Elek-Tro-Cut Three-M-ite Cloth Spiral Wound Strips are used the problem is solved once and for all.

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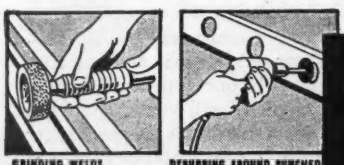

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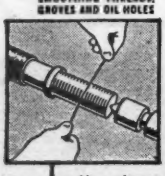

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will be very difficult to straighten out. If wrinkles appear in the flange and are not too bad, they can often be worked out with the tool by holding a smooth hickory stick (called the "backstick") solidly behind the wrinkles. If this method fails, the spinning should be taken from the chuck and the flange hammered smooth.

After the breakdown operations are all completed, a final spin is made to lay the shell tightly against the chuck, starting at the tailstock and working outward. The metal should never be loose at any point. If the metal is not tight against the chuck, it makes a hollow sound when tapped with a wooden mallet. It is almost impossible to lay a loose intermediate section to the chuck if there is a tight fit at both ends.

In the trimming operation, the edge is turned back slightly and the trimming tool is held lightly but firmly against it. If beading is desired, the flat tool is placed on the right side of the rim and the curl is started for the bead with the hickory stick. The edge may now be rolled entirely over, using the beading tool to finish the job.

After all operations are completed the shell is removed. In case it sticks to the chuck, it should be given a "once over lightly" with the planishing tool as it spins.

Intermediate chucks may be used to break down a blank if the shape is too severe to form in one spinning operation. A typical example is the end of an airplane fuel tank. It may first be partially formed in a regular draw press in one or more operations, then brought to the lathe for spinning. Because of the thickness and temper of the metal, a helper is needed to add his weight to the spinning stick. Since this tank must be spun so near the end, a series of different size tail blocks are used to provide an increasingly better grip on so large a shell.

The number of spinning chucks (or the number of reductions) depends on the shape of the finished product, as well as upon its diameter compared with that of the blank. In general, shells with perpendicular sides require more chucks than those with sloping sides.

After spinning, hemispherical shells will have a flat bottom equal in diameter to that of the back-up block. This can be hammered out to whatever radius or shape is required.

A form of spinning requiring highly skilled artisans is called "spinning on air." A straight-sided shell, either spun in the usual manner or drawn, is inserted in the lathe. The operator does not use a chuck, but merely uses the tool to form the desired shape. This method is often resorted to when close dimensional tolerances are not essential. The work must be frequently checked against a template.

Aluminum sheet in thicknesses from 0.025 to 0.081 in. is usually spun by hand, although metal thinner than 0.025 in. can be spun with special care. Metal of greater thickness than 0.081 in. is usually spun by semi-mechanical or entirely mechanical methods.

The semi-mechanical method differs principally in the application of the tool

to the work. Two hand-operated feed screws are used to control the motion of the tool. The right hand feed controls the longitudinal movement, while the left hand feed moves the tool in and out, following the contour of the chuck. This method takes less strength than hand spinning but requires considerable skill.

In the entirely mechanical method, the tool is rigged up to travel automatically back and forth the length of the shell. Compressed air advances the tool step by step as the work is being pressed tightly against the chuck.

Some giant mechanical spinning lathes are capable of accommodating seven foot blanks. In lathes of this type, highly polished steel shoes or forms serve as the tool and are applied to the work by hydraulic pressure. A mechanical variation of "spinning on air" has idler rolls which operate against the metal in opposite directions. These rolls take the place of the forming tool.

Parks Student Airline

(*Continued from page* 183)

of the student captain. Another task of the radio operators is to send and receive all the reservation, load, and dispatch messages. They receive requests for space from the traffic representatives to be sent to the other stations along the line.

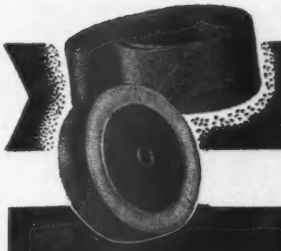
Two radio booths are utilized for this purpose. One operator sends the message via radio telephone or code to the operator in the other booth representing the other station. This operator sends the reply, either confirming or refusing the request for additional space. Regular interline and intraline code words are used for these messages.

Students serving as the traffic representatives handle all requests from the student passengers seeking reservations. Many problems are presented in this manner and the passengers are encouraged to present those problems that will best demonstrate the ability of the sales personnel. Using standard airline guides and tariff regulations, fares and schedules are quoted to the passenger with a minimum of delay.

Working in connection with the sales people are the students acting as space control operators. Master charts are prepared showing the space assignment for the various stations along the route, and each salesman must secure his space from control before he can confirm it to the passenger. Patterned after the space-control system of one of the largest airlines in the country, this department is responsible for maintaining an accurate check on all space sold, released, or acquired from other stations.

Direct telephone connections between this department and the sales desk assures instantaneous and positive service. After the flight has left the station, these men will prepare the necessary space-release messages and see that they are sent to the next station for possible sales there.

One of the busiest departments of any airline is the ticket counter, particularly



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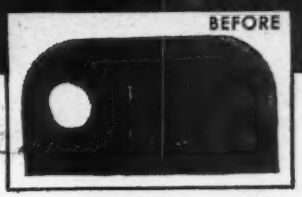

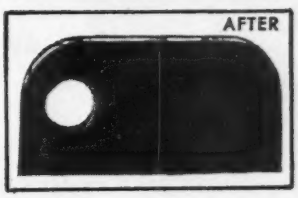

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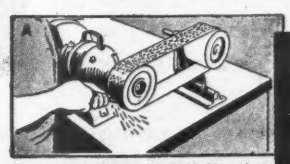
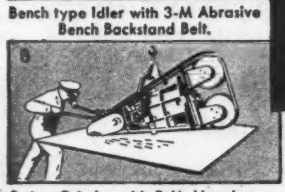


Bench type Idler with 3-M Abrasive Bench Backstand Belt.



Swing Grinder with 3-M Abrasive Swing Grinder Belt.

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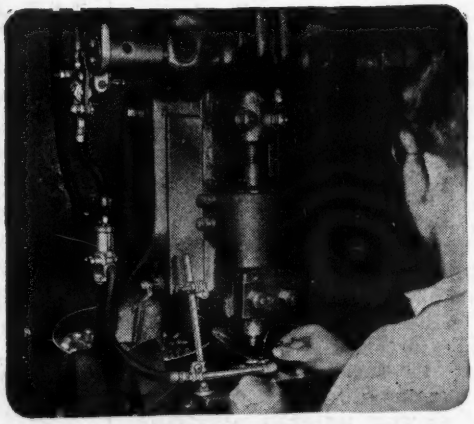

Note how work is BLOWN into barrel.

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at flight departure time. PACA is no exception. Staffed by students with training in the issuing of tickets and passenger handling problems, this department functions as smoothly as any airline ticket counter ever functioned. Student passengers who hold reservations are checked in 10 min. before flight time and are then issued their tickets. Passenger manifests are prepared, and the passenger's baggage is weighed and tagged. Excess baggage charges are collected at the rate of 0.5 percent of the published one-way fare, plus the government tax of 3 percent. Students serving behind the counter are faced with all of the regular problems that confront the airlines today.

Priority passengers and passengers who have been removed for priority, are handled with tactfulness. A daily report is made of the passengers who have been removed to accommodate a priority passenger, and the Station Manager sends this passenger a follow-up letter explaining the priority system to that passenger. Each clerk at the **ticket counter** has his own supply of tickets and a cash drawer containing a sum of stage money. At the end of each day's operation he is required to balance out his tickets and cash in the same manner as required by the major airlines.

Helping out at the ticket counter and on the ramp is the passenger agent. This student aids the passengers with their problems and sees that their baggage is turned over to the cargo department for handling. It is his duty to check on the status of all the passengers and decide whether or not they shall make the trip. He also serves as the Steward of the flight, in that he checks in the passengers at the airplane during the boarding operation.

After the passenger's baggage has been weighed and checked, it is taken to the cargo department by the passenger agent. Here the cargo handlers sort it out for the proper trips. The cargo agents are also responsible for the mail and express load. Dummy packages prepared by the students are presented for shipment via air express and the agents prepare waybills and collect the necessary charges. Serving as the Airmail Field Office, the cargo department also originates dummy airmail pouches for shipment. These students have studied the latest airmail regulations so that ample protection is given the mail. The preparation of the necessary mail forms—the 2702 and 2715 sheets—is also handled by the cargo agents. When the students have completed their cargo load forms, they are turned over to the station agents for the completion of the master load computation form.

The station agents are responsible for seeing that the gross weight of the airplane is not exceeded. They use a form similar to those provided to the regular station agents for this work. They must see that not only is the proper load carried but also instructions for the proper loading of the cargo are carried out.

Another of the duties of the station agent is to make sure that the clearance form is prepared as far ahead of flight as possible. Working in connection with the flight superintendent these station agents

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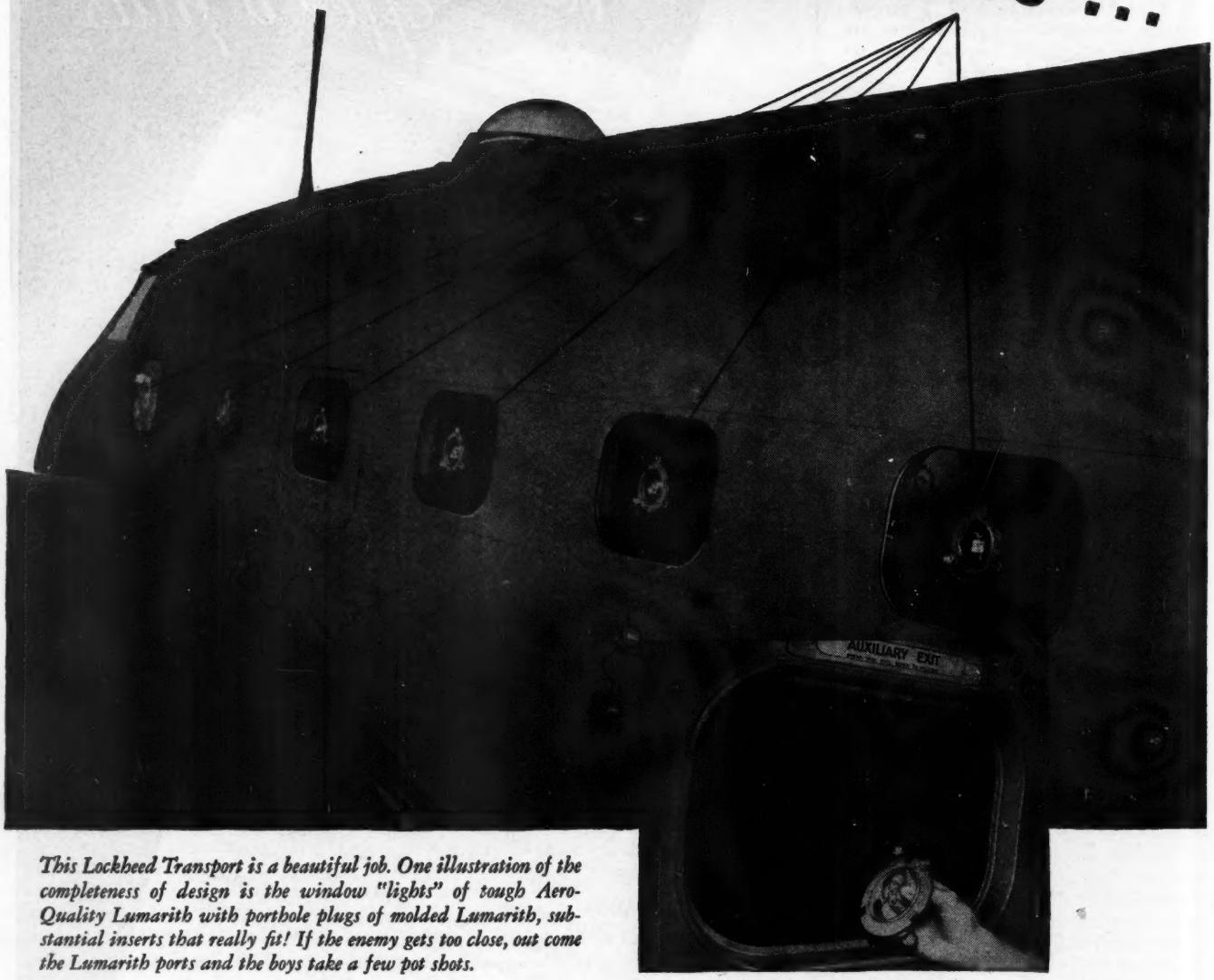

This Lockheed Transport is a beautiful job. One illustration of the completeness of design is the window "lights" of tough Aero-Quality Lumarith with porthole plugs of molded Lumarith, substantial inserts that really fit! If the enemy gets too close, out come the Lumarith ports and the boys take a few pot shots.

Here is an application that shows Lumarith doing business in two forms. The windows are Aero-Quality Lumarith sheets—the high impact strength transparent plastic developed for aviation use. The ports are molded from Lumarith molding materials.

The general toughness of Lumarith and its ability to withstand torque have strong appeal to aircraft designers. To make full use of this quality, some interesting designs are on the board. If you haven't received a copy of the second edition of Lumarith Mounting book giving data on the subject, send for a copy. Celanese Celluloid Corporation, The First Name in Plastics, a division of Celanese Corporation of America, 180 Madison Avenue, New York City.

LUMARITH*

A Celanese Plastic*

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originate a flight clearance and weather form that is identical to the standard type. These same employees will also prepare the load and dispatch messages necessary after the flight leaves the station. Their duties on the ramp include giving the arrival and departure announcements over the public address system and signaling the airplane to and from the ramp.

On each flight, only two student passengers are carried. While 21 seats are "sold," only two can make the flight because of the size of the airplane. These two students, however, do not sit back and enjoy the trip as regular airline patrons. One acts in the capacity of Navigator; the other as Trip Meteorologist. The Navigator maintains a complete navigation log of the trip and must keep the Captain informed as to the flight's progress.

With a background of nine months of study in navigation that even includes celestial navigation, this student is now given the practical experience his classroom work has been qualifying him to handle. The trip meteorologist is given a chance to observe just how accurate his forecast was. This is an interesting experience, for after the first few flights he is well aware of the problems faced by the captain on his trips.

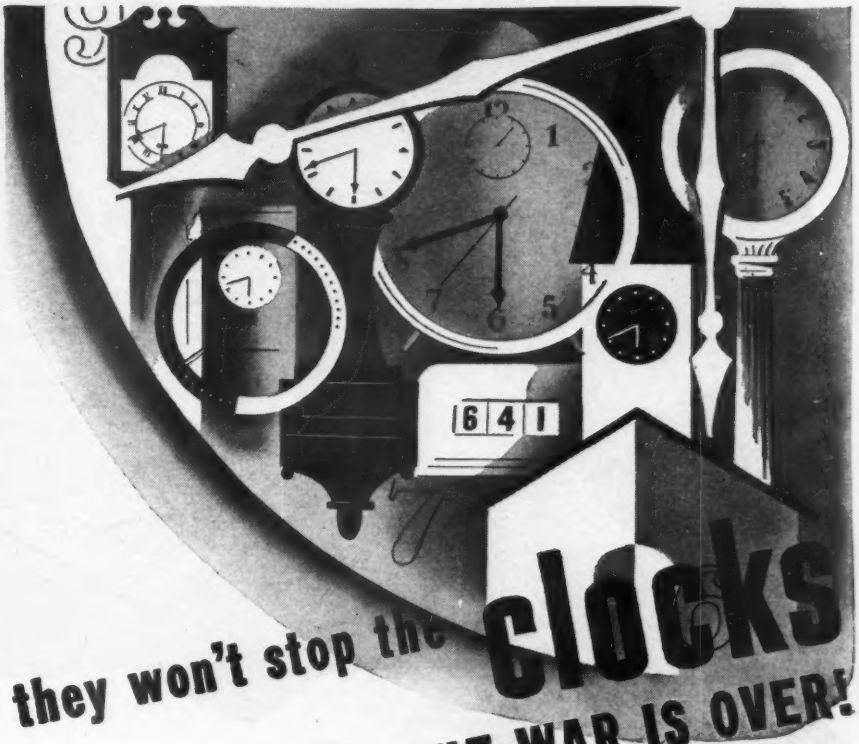
When the trip reaches the other end of the run, the flight agents will open their sealed orders that have been carried on the trip. These orders contain the necessary information for working the return trip. When the flight starts back after approximately a 3 hr. stay, all the forms must again have been completed by the flight agents and the flying crew assigned to that run.

Upon the arrival of the flight at the home base, the station again functions exactly like any airline working a trip in. Arrival announcements are given by the station agents, and the unloading of the airplane is as carefully carried out as was the loading. Passengers claim their baggage at the terminal building, and the "airport car" leaves for downtown St. Louis immediately.

The line mechanic, also a student, holds his airplane and engine licenses and is responsible for the mechanical condition of the airliner. His work begins early in the morning with the pre-flight inspection of the airplane, and it ends only after he has completed his evening inspection. Orders issued by the Flight Superintendent for the gassing of the airplane are given the mechanic as soon as he checks in at the airline office on the morning of flight.

On days when weather cancels out an actual flight, a theoretical flight is made to one of the cities, with all of forms prepared in the same manner as if the trip were flown. On days when flights are not scheduled, time is spent in going over the previous operations and analyzing the difficulties encountered by the student "employees."

The position of station manager, which has already been mentioned, carries its share of responsibility and the student holding this important position must maintain his station on a business-like basis. Working directly with the operations



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manager (the position held by the airline instructor) he checks on each day's operation and prepares a progress report on each employee. On his recommendation, students are advanced to new positions in the same manner that promotions are granted with a regular airline.

All in all, the operation of the Parks Air College Airline follows, as closely as possible, the operation of any domestic airline. The young men receive practical training that really could be called an apprenticeship for the airline career field.

It is to the credit of the students that PACA has maintained a perfect safety record throughout the 10 yr. of operation and that the percentage of trips operated is very high. These facts, coupled with a 100 percent load factor, emphasize the point that PACA is an important educational project for the air age.

Cellulose Acetate Plastic

(*Continued from page* 149)

tensile specimen, and a 45° helix in the torsion specimen; and there was no evidence of local "necking-down" in the tensile specimen. The modulus of elasticity in tension was about equal to the average modulus of elasticity observed in the compression tests, and the modulus of elasticity in shear was about 1/3 of that of the tensile modulus.

Poisson's Ratio

No tests were made to determine Poisson's ratio, μ, by direct measurement, and the values of modulus of elasticity in tension and in shear were not accurate enough to calculate Poisson's ratio from elastic theory with good precision.

However, the following results were obtained: The elastic theory gives the relation—

$$\mu = \left(\frac{E}{2G} - 1\right)$$

where E is the modulus of elasticity in tension (or compression) and G is the modulus of elasticity in shear. The value of μ was about 0.53 to 0.56, depending on whether the modulus E was obtained from the compression or the tension test. This value is a little larger than the theoretimaximum value of ½.

Effect of Testing Speed on Tensile Properties

Another series of tension tests performed at an earlier date showed the effect of speed of testing for a wide range of testing machine speeds. The data for these tests are shown in Fig. 9, in which are plotted the upper yield point, the lower yield point, the fracture stress, the reduction of area, and the elongation in 2 in. (measured at the instant of fracture) as functions of the no-load head speed of the testing machine. The no-load head speed was used here for convenience.

The reduction of area is the final area of cross-section expressed as a percentage of the original area, and the elongation is the change in length at time of fracture of an original 2-in. gage length expressed

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as a percentage of the original gage length.

Fig. 9 shows that the upper yield point, lower yield point, and fracture stress all increase with increasing head speed until a critical speed is reached at about 1.5 to 2 in. per min. beyond which they remain substantially constant. There was also an indication that both reduction of area and elongation decrease with increasing head speed.

Aging

A comparison of the results of the tension tests reported above with the tests reported in the first section for the same material shows that the strength of the material has increased with age. The age of specimens at time of tests reported above was about 2,000 hr. (taken from the start of the investigation), and the age at the time of the tension tests reported in the first section was about 11,000 hr. During this time interval of 9,000 hr. the upper and lower yield point increased about 4 percent at the rate of strain of 0.0016 per min. and about 8 percent at the rate of strain of 0.04 per min. The fracture stress increased about 12 percent for both speeds, and the strain at fracture increased about 4 percent. An increase in the modulus of elasticity of the specimens— about 15 percent—was also observed.

Effect of Transverse Hole On Tension Test

Tensile specimens containing a circular transverse hole of 0.082-in. dia., as shown in Fig. 1d, were tested in tension to determine whether the tensile properties of the material would be affected by the stress concentration or the stress gradient resulting from the hole.

Specimens were tested at three different head speeds, which resulted in rates of strain (measured over a 2-in. gage length) equal to the rates of strain used in the tension tests measured above. Readings of load, deformation, and time were taken throughout the tests, and from these data the rate of strain in a 2-in. gage length and the average stress at fracture were determined. The stress-strain diagram for the specimens with the hole differed from that for the solid specimens in that no yield point was observed. The load increased continually to a maximum value at which fracture took place. Total extension of specimens with a hole (as measured over a 2-in. gage length) was only about 8 percent of the elongation of the solid specimens.

The ultimate strength was computed by dividing the maximum load by the net cross-sectional area at the hole. At a rate of strain of 0.04 per min. the ultimate strength was 5,090 psi.; at a rate of strain of 0.0077 per min. the ultimate strength was 4,350 psi.; and at a rate of strain of 0.0016 per min. the ultimate strength was 3,920 psi.

As in the case of the other tests, the effect of increasing the rate of strain was to increase the ultimate strength. The corresponding values of ultimate strength for unnotched specimens were 5,520 psi., 5,000 psi., and 4,490 psi. Comparing these values with the values for the specimens

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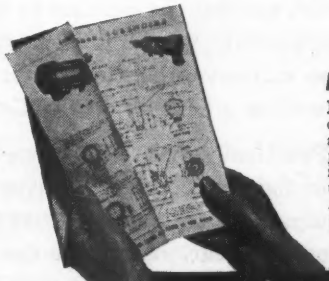

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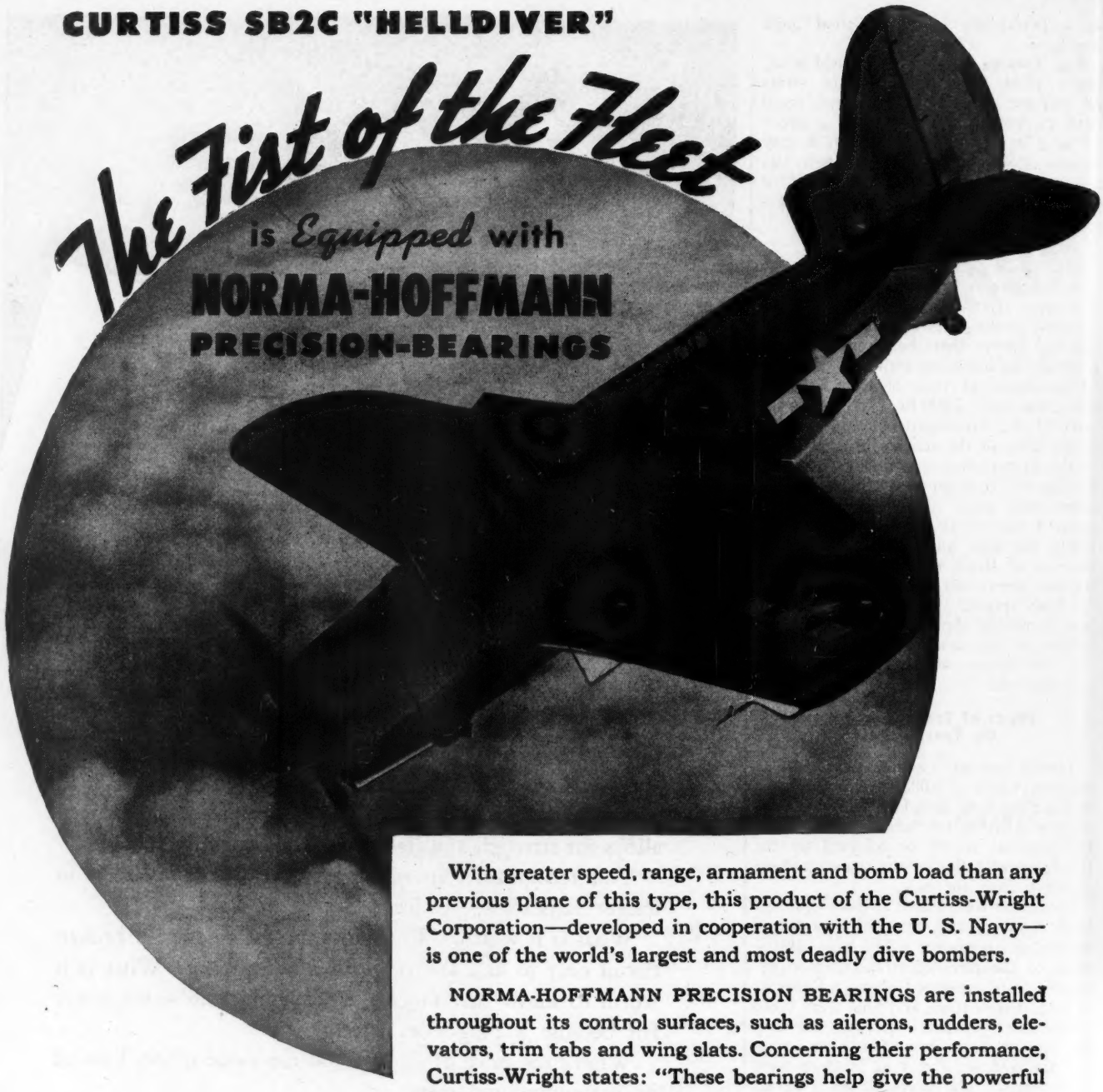

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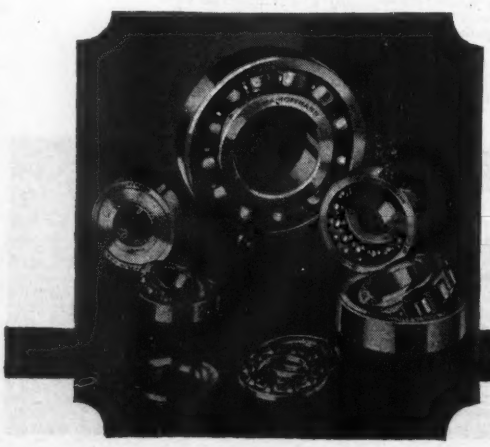

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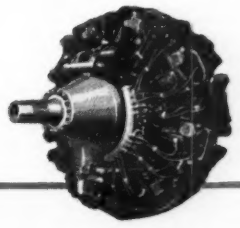

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- In peacetime will be standard on commercial planes.
- Can be used over and over again.
- "Outlast the plane."
- Approved by all government aviation agencies.

This is one type of the famous Boots All-Metal Self-Locking Nut—set in straight or curved channel for fast assembly.

containing holes, it was evident that the hole resulted in a decrease in ultimate strength of 8 to 13 percent.

Cause of this decrease may possibly be explained as follows: The fracture in a tension test of a specimen without a hole occurred on a plane at right angles to the axis of the specimen. Thus failure resulted from separation of the material under a tensile stress, starting usually by a small fissure at the surface of the material. In tests of the specimen with the transverse hole, it was observed that all of the plastic deformation occurred in two wedge-shaped areas starting at the hole and spreading fan-like to the sides of the specimen. Under this condition the deformation was approximately uniformly distributed over the cross section of the solid portion of the specimen so that the total axial strain adjacent to the hole was much greater than that at the sides of the specimen where the amount of plastically deformed material was the greatest.

Thus the stress distribution was not uniform during plastic extension at the cross section containing the hole—i. e., the stress gradient was not zero. Stresses were much higher near the hole than at the sides. Since failure occurred by a crack starting at the hole and spreading rapidly when once formed, one might conclude that the average stress at the time that a crack started in the specimen with the hole was less than the average stress which caused a crack to start in the solid specimen. Thus the ultimate strength of the specimen with the hole would be smaller than the ultimate strength of a solid specimen.

Engine Production

(*Continued from page* 151)

ring to produce a more severe oil scraping action. This, in turn, greatly reduces oil consumption.

Chamfering also prevents rapid increase in the width of the land as the rings wear to a seat during the breaking-in period. It is now possible to operate engines a full 800 hr. before oil rings must be replaced, whereas formerly rings had to be replaced after about 500 hr.

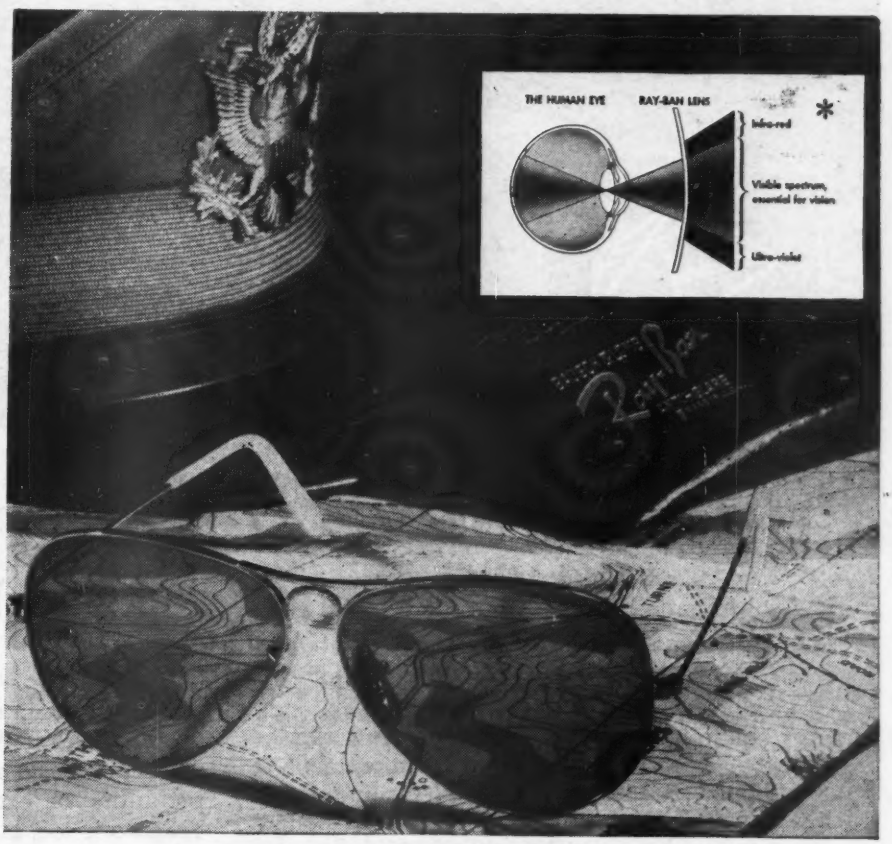
"Setting" Time Decreased

Outside diameters of compression rings were formerly ground to produce a smooth surface. This was found to result in severe wear during run-in and in earlier feathering of the edge of the ring, ultimately resulting in failure of lubrication of the bearing surface of the ring. Accordingly, experiments were made using a turned, rather than ground, surface. It was found that the minute valleys left by the turning tool afforded space on the ring bearing face in which oil is held. This thread-like diameter reduces the area of ring contact with the cylinder, thus decreases the time for "setting" or wearing in the ring to a proper surface. Fig. 8 details how the ring surface is now finished.

To avoid the use of stock of large diameter and the milling of a hex head on a carburetor hold-down bolt having a flange under the head, the flange was made as a separate piece and brazed to the under side of the head. This bolt (Fig. 9) is now produced in one piece from stock only slightly larger than shank diameter, both the head and the washer being upset in a cold-header. Only enough excess stock is left for grinding to secure the high grade finish required. The thread, which is a class-3 fit, is rolled, since this affords a smoother finish than a cut or ground thread and yields a thread well within the close tolerances specified. A small radius is left where the flange joins the shank.

Cold-headed bolts of this type possess ample strength and are produced with virtually no waste of stock. Naturally, the bolts cost much less than those machined from bar stock. Also a more favorable grain flow results from the upsetting action.

In Fig. 10 are shown the old and new methods of fastening the scavenging and vent pipes to the reduction gear housing. When, in the old method, the pipes were rigidly fastened, breakage of the pipes sometimes occurred in assembly. But in the new method, fittings are threaded and have above them Neoprene washers which provide a degree of flexibility. The result is to eliminate breakage in assembly.



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Ray-Ban is the name of a type of glass created by Bausch & Lomb for exactly that sort of performance, and made to Government specifications to meet the needs of American military aviation. For twelve years Ray-Ban lenses and Ray-Ban Sun Glasses have been used to equip the Army and Navy. And thousands upon thousands of civilians have found in Ray-Ban's comfortable, scientifically correct glare protection the perfect answer to eye distress, the ideal glass for outdoor wear.

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Carrier-Based Aviation

(*Continued from page* 111)

gear was a friction drum development which controlled the runout. This resulted in a considerable saving in weight, always an objective of prime importance.

This improvement was incorporated first in the converted *Saratoga* and *Lexington*, then in the *Ranger*, the first ship to be built from the keel up as a carrier. Paralleling the development of the modern airplane has been the development of the ship's arresting gear and other facilities, which have led to our present highly perfected carrier.

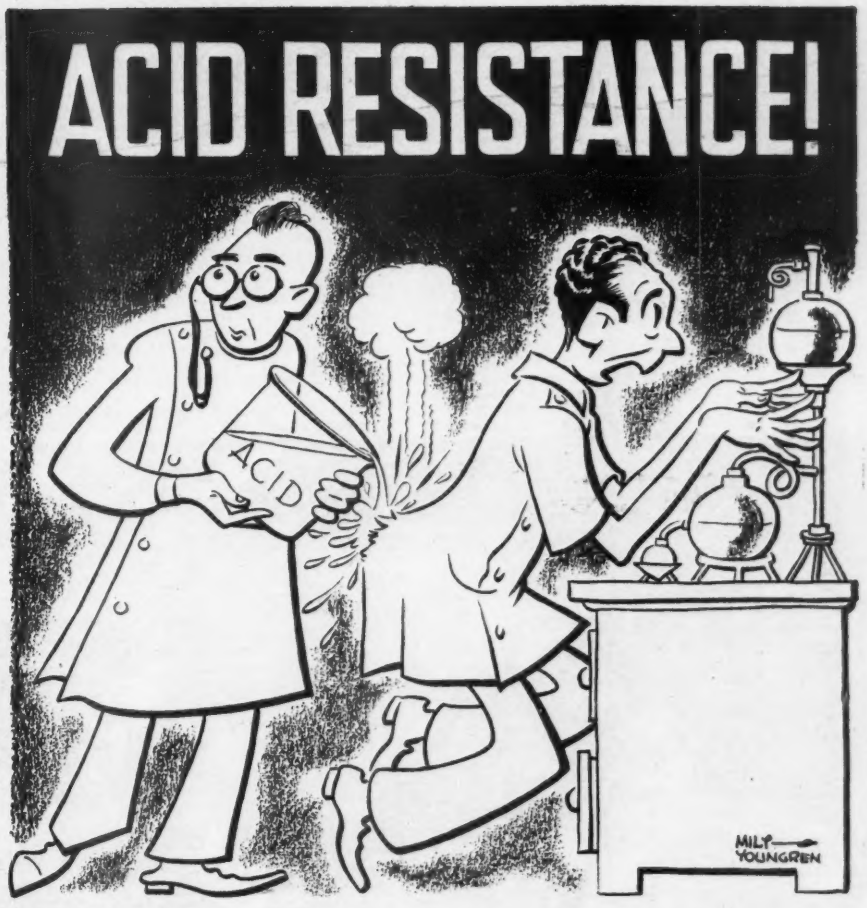
The modern airplane, with its increased speed, however, requires greater strength for arresting. The use of catapults also calls for additional structural weight necessary to absorb catapulting forces. As the efficiency of the plane improved, the problems of adapting it to the carrier increased. The solving of this multitude of technical problems is an impressive story. For security reasons, however, it can not be told in detail until after the war.

Aeronautical science has reduced the carrier plane's handicaps. Skillful design has been perhaps the most important factor. The wing is clean and lines are trim. All materials are carefully chosen to keep the weight as low as possible, yet to provide sufficient structural strength. New developments in engines and propellers also have been major contributions.

The Navy wing is carefully designed. In spite of its mechanically folding feature, the wing easily withstands the high pullout forces resulting from dive bombing and fighter tactics. Dive bombing has been found to be particularly effective against ships. In this type of attack Navy pilots plunge down a vertical flight path to deliver their loads of destruction. The *Dauntless* and the *Helldiver* have become the terror of enemy shipping. The *Avenger* is unsurpassed as a torpedo bomber. It is designed to close with the enemy at high speed and at low altitude in order to launch a torpedo before the target ship can maneuver to avoid it.

As a result of engineering skill, many of the carrier plane's limitations actually have been converted into assets. Our modern plane closely approximates the speed of the land-based plane. The larger wing affords maneuverability in the air, permitting a tighter turn. This is particularly advantageous in close-in fighting, if tail chase tactics are used. Navy planes have a smaller turning radius, which brings them inside the opponent, and in position to give a deadly burst of gunfire.

There are other features on the profit side of the ledger. All carrier air operations are made from sea level; thus wings, engines, propellers, and instruments can be designed with the knowledge that there will be no variation in the altitude of the "flying field." Take-offs never need be made in a flat calm, for the carrier can generate wind by its own forward speed. Heavily loaded planes can be launched at satisfactory flying speed by employing the carrier's catapult.



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The modern carrier has been developed into a compact, efficient and highly mobile airbase, with excellent airplane operating and repair facilities. These include communications, weather information, fuel ammunition, spare parts, and, a feature which promotes the efficiency of combat aircrews, clean, comfortable quarters with wholesome food served in the manner of an American home.

Admittedly, airplanes which operate from carriers must have features in their design which tend to place them at a disadvantage in comparison with planes operating from shore bases. With these features skillfully designed, however, the penalties are almost negligible. The compensations are evident when one sees in action the tremendous concentration of mobile air power in our modern carrier task forces.

Review of Patents

(*Continued from page* 195)

Multiple-Container Chute Rig provides for separate containers covering range of required paratroop equipment to be arranged on appropriate launching device for dropping in series by a single parachute. Launching "trap" in plane would also serve as a loading means.—2,345,615, filed Apr. 25, 1942, patented Apr. 4, 1944, F. G. Manson and J. J. Maskey, for free use by government.

Aerial Delivery Gun Container relates to chute-borne housing for rifles or machine guns. For protection against severe shocks, special end bumpers are provided. Container is cylindrical, with intermediate radially disposed partitions forming a number of gun compartments.—2,345,616, filed Apr. 25, 1942, patented Apr. 4, 1944, F. G. Manson and J. J. Maskey, for free use by government.

Landing Gear. Here two main landing wheels are in normal position while third wheel is disposed at rear, either beneath tail or between tail and main wheels. Arrangement is such that aircraft can be landed in position approximating normal level flight as distinct from tail-down position. Third wheel can be raised if required—for instance on trainer craft when it is desired to instruct a pupil in tail-down landings or takeoffs.—2,346,010, filed May 18, 1942, patented Apr. 4, 1944, L. E. Cowey.

Retractable Undercarriage Mechanism. This patent relates to undercarriage comprising two wheels, supports on which wheels are carried, bearings for supports, and driving connection between plane's propellers and the supports, change in line of thrust of propellers after takeoff would rotate supports, swinging wheels into retracted position; another change in thrust of airscrews at time of landing would similarly move undercarriage wheels into landing position.—2,346,280, filed Apr. 5, 1939, patented Apr. 11, 1944, R. Tampier.

Illuminated Landing Field. Without use of any superstructure or any parts projecting above level of landing surface, an illuminated landing field is here provided by use of sub-surface lights sending rays up through translucent materials employed in field surfacing. Invention treats of materials, for this use, which will be resilient and resistant to both skidding and breakage.—2,346,805, filed May 20, 1940, patented Apr. 11, 1944, E. C. Henderson and G. Stallard.

New Bomb Rack, having means for supporting a plurality of bombs, is designed for dropping from plane with bombs still affixed, means being provided for automatically releasing bombs from rack after latter has fallen a predetermined distance. Firing mechanisms for individual bombs are released only after rack has dropped away from plane.—2,246,494, filed Dec. 3, 1940, patented Apr. 11, 1944, G. H. Leland.

Propeller Fabrication. Instead of forming propeller's intermediate portion of solid mass of material, this patent calls for channeling of material from hub part way outward to reduce weight and accordingly provide airscrew which has substantially similar thickness in its various portions.—2,346,552, filed May 27, 1939, patented Apr. 11, 1944, R. C. Brotz.

Undercarriage. This gear has special means for locking it in "down" position. There is also provided a novel support for oleo strut, upper end of strut being fitted into rotatable cross beam supported by two fixed bearings. Hydraulically operated crank on one end of cross beam rotates beam to retract strut. A drag strut has one and attached to oleo strut while other end is supported by trolley on track.—2,346,797, filed Apr. 16, 1941, patented Apr. 18, 1944, J. H. Stephens, assignor to The Glenn L. Martin Co.

Integral Armor. Invention embraces concept of making basic structural members of airplanes out of armor plate to enable such parts to afford protection while serving in their ordinary structural capacity. Considered are such structure as wing beams and bulk heads.—2,346,809, filed Sept. 20, 1940, patented Apr. 18, 1944, R. J. Woods, assignor to Bell Aircraft Corp.

Airplane Safety Chair provides Automatic restraining means to retain a person in his seat, but permitting him to rise upon removal of his weight from seat. Structure includes pair of opposed gates pivoted to seat frame. When occupant seats himself, gates fold over his lap.—Occupant may then lock gates.—2,346,871, filed May 28, 1941 patented Apr. 18, 1944, G. Provenzano.

Airplane Exit. Particularly for cabin type craft, invention offers special means for emergency exit of parachute-provided occupants during flight. Fitted is special door which, in emergency, may be made to pivot on downstream edge rather than

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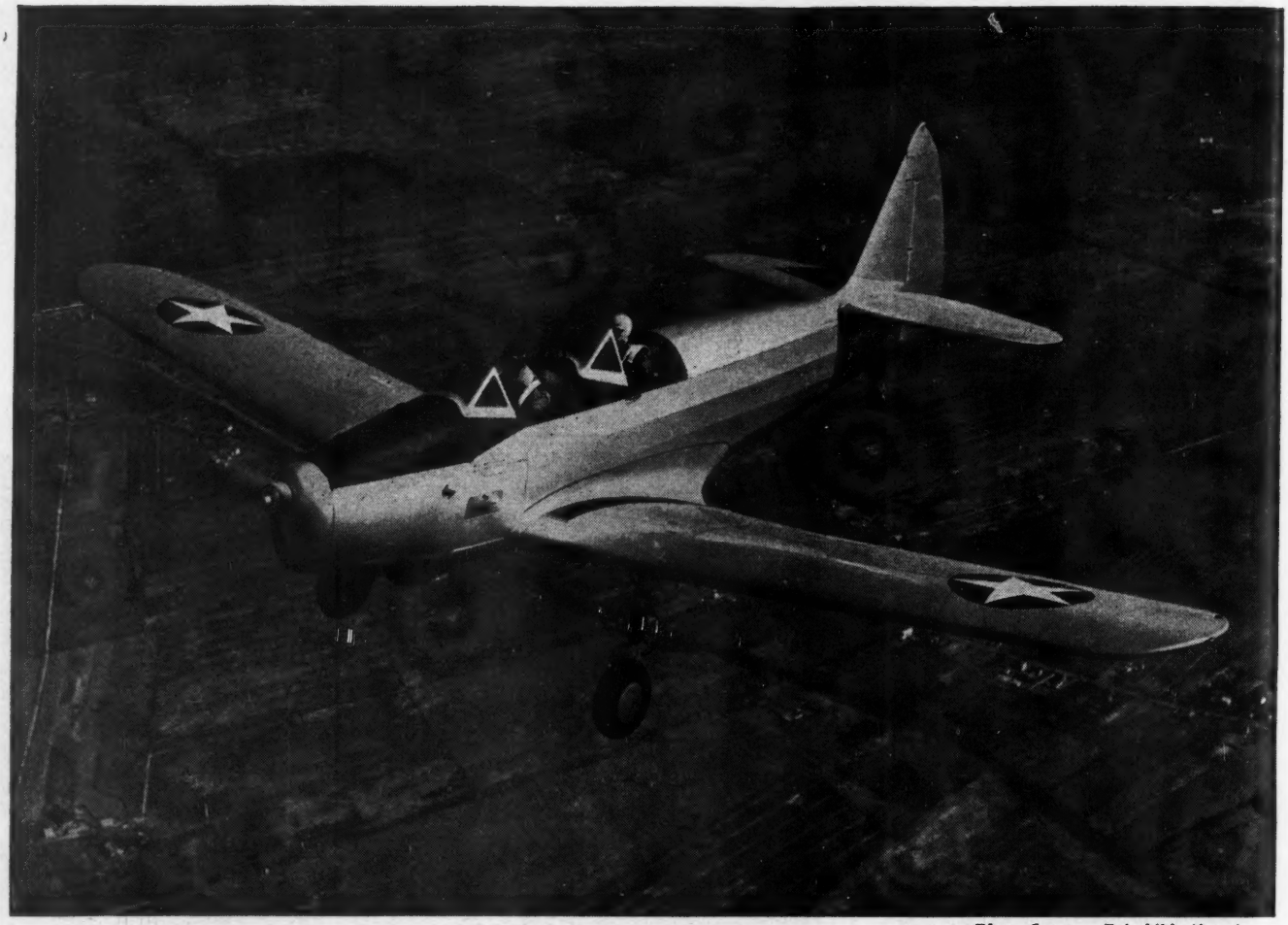

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GLOBE STEEL *Tubes*

GLOBE STEEL TUBES CO. *Milwaukee 4, Wisconsin, U. S. A.*

conventional upstream edge. Accordingly, force of airstream, will swing door outward, until it is blown completely clear of airplane.—2,846,977, filed May 9, 1941, patented Apr. 18, 1944, S. S. La Sha, assignor to Bell Aircraft Corp.

Aerial Delivery Container. For paratroops, this container is in form of a small wooden closet with sheet metal bands, one at top edge, one at bottom edge, and with U-shaped sheet metal strap extending across bottom and up sides, this strap being secured to top and bottom bands. Parachute-attachment means is provided at top of container. Door in front of container slides vertically in sides.—2,347,205, filed Apr. 8, 1942, patented April 25, 1944, W. L. Lindsay and H. Wilson, for free use by government.

Non-Stall Plane. Offered is design for craft stated to afford glide-angle control providing greater inherent safety for novice and amateur flyer. Craft calls for special construction to make stalls, spins, or excessive diving impossible, either intentionally or unintentionally.—2,347,280, filed Dec. 16, 1938, patented Apr. 25, 1944, D. R. Zuck.

Laterally-firing Bomb. This bomb is fitted to fire a series of bullets radially so that a wider area may be covered by destructive action. Bullets are shot electrically (via battery) as bomb descends.—2,847,279, filed May 20, 1941, patented Apr. 25, 1944, S. J. Piut.

Book Reviews

(*Continued from page* 195)

CELESTIAL NAVIGATION, by Walter Hadel. Whittlesey House, N. Y. 284 pages, graphs, appendix, solutions. $3.25.

Primarily a manual, with emphasis placed upon problems rather than theory. Method of approach is to take the reader on imaginary flights in which position is determined by celestial fixes. Author uses three methods of celestial fixing (H.O. 214, Weem's Star Altitude Curves, and H.O. 211) in finding solutions. Book is entirely self-contained in point of its subject, no other texts or tables being necessary for solutions.

PRACTICAL ANALYTIC GEOMETRY WITH APPLICATIONS TO AIRCRAFT, by Roy A. Liming. The Macmillan Co., N. Y. 303 pages, graphs, appendix, tables, index. $4.50.

Study of "the application of analytic geometry to a practical mathematical definition of airplane contours and surfaces." Prepared for plane designers, the book's main body is divided into three parts. Part 1 analyzes the applications of analytic geometry to two-dimensional space; Part 2 develops the application of rectangular coordinates to three dimensional space; and Part 3 develops and applies a system of analytic analysis to curves commonly required in the lofting of streamlined bodies.

AIRCRAFT INSTRUMENTS, by George Ellis Irvin. McGraw-Hill Book Co., N. Y. 607 pages, illustrations, appendix, index. $5.

Revised and enlarged edition. The subject matter has been amplified, particularly in chapters touching on electrical type thermometers and temperature gages and other electrical instruments and meters; the vapor-pressure manifold, the Weston A.C.-D.C. tachometer, synchronizer circuits and instruments; Kollsman HP. indicator; Kollsman accellrometer; Pioneer Magnesyn compass and fuel flowmeter. Emphasis has been placed on the exposition of electrical instruments because of the trend in that direction."

BASIC AIR NAVIGATION, by Elbert F. Blackburn. Whittlesey, N. Y. 300 pages, illustrations, computer charts, index. $4.

Analysis of the avigator's problems from alpha to omega, all phases of which are covered in the actual order encountered in practice. The approach is graphic, with problems reduced to their lowest common denominator. Highly comprehensive, with most impedimenta to a practical grasp considerably modified.

AIRPLANE MAINTENANCE, by John E. Younger, Allan F. Bonnalie, and Nairne F. Ward. McGraw-Hill Book Co., N. Y. 361 pages, illustrations, appendix, index. $3.

For the civilian and military repair-station man. Consideration of planes and plane-repair materials and how they are worked and applied comprise the greater part of the book. There are also chapters devoted to theory and to the mathematical aspects. Profusely illustrated. Minute detail, particularly on safety factors, is a welcome note.

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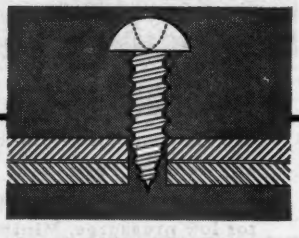
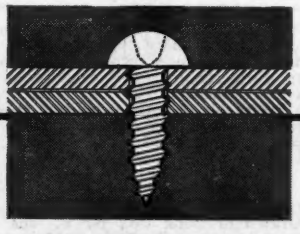


American Phillips Driver and Screw form a single, straight-line driving unit . . . and stay that way until screw is completely driven in.



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ROCKETS, by Willy Ley. Viking Press, N. Y. 287 pages, illustrations, notes, addenda, bibliography and index. $3.50.

The story of the rocket from its earliest stages, through present-day status, and on to a projection of its possibilities. Emphasis is placed upon the importance of early Russian and later German work. The author is qualified on the subject due to his connections with the progress of the rocket-propulsion idea, initially in Germany. He discusses the background of the rocket motor thoroughly, then states the case for its successful application.

ATLAS OF GLOBAL GEOGRAPHY, by Erwin Raisz. Harper & Bros., N. Y. 63 pages, colored map illustrations, charts, graphs. $3.50.

A new approach to geography, designed for the standpoint of the air age. Maps in the book give fresh viewpoints. Much of the material is statistical, but resemblance to usual atlases end there. Intent is to give "a plane's eye view of tomorrow's geography."

ENGINEER'S DICTIONARY (Spanish-English). Wiley, N. Y. 423 pages.

With South America, a continent largely traveled by air, coming closer to us through air transport, this dictionary will be found valuable by both South and North American plane engineers with an eye on the future.

AIRCRAFT ANALYTIC GEOMETRY, by J. J. Apalategui and L. J. Adams. McGraw-Hill Book Co., N. Y. 281 pages, illustrations, appendix, tables. $3.

A new approach to special problems arising in the engineering, lofting, and tooling of airplanes. Basing their presentation upon ideas and mathematical methods developed in Douglas' tooling division, the authors have presented a complex subject in simplified and self-explanatory form.

ANGULAR SPACING TABLES, by Dr. Werner F. Vogel. Vinco, Detroit. 233 pages of tables. $10.

This book presents mathematical angular spacing tables to conform with the accuracy of modern mechanical devices. Calculations and formulas are given "at a glance."

WINGS AFTER WAR, by S. Paul Johnston. Duell, Sloan and Pearce, N. Y. 129 pages. $2.

Survey of the postwar aviation from the viewpoint of the average man, the job-seeker, and business interests. The book coldly appraises the chances for an expansion of aviation, giving glimpses into the possible future. Though optimistic, the author hews close to the debunking line.

STICK AND RUDDER, by Wolfgang Langeweische. Whittlesey House, N. Y. 389 pages, illustrations, index. $3.75.

A stab in the direction of an exact analysis of the art of flying. Treatment and method are from the standpoint of the imagination coupled with common sense. Visual and graphic images are projected as a means of giving the student a precise picture of the problems he must solve. Langeweische speaks with authority and from experience.

MARINE AND AIR NAVIGATION, by John Q. Stewart and Newton L. Pierce. Ginn & Co., Boston. 472 pages, illustrations, graphs, photos, tables, star charts, index. $4.50.

Presented as a "compleat" navigator, with emphasis on the unity of navigation and avigation. Piloting—charts for sea and air and map projections—is set forth in detail. Celestial phases of the subject are happily freed from unnecessary astronomy, though astronomy is appended for those desiring it. Treatment is accorded to relative motion, drill problems, radio navigation, azimuths, historical navigation, and countless other angles. Star charts and colored maps are designed with an eye toward visual clarity. The volume offers numerous cases in point and valuable hints.

CALCULUS REFRESHER FOR TECHNICAL MEN, by A. A. Klaf. Whittlesey House, N. Y. 431 pages, formulas, appendix, logarithmic tables, index. $3.

Essentials of the subject are developed by means of questions and answers. The book is divided into customary sections, first on differential calculus, secondly on integral calculus, with inclusion of an introduction to differential equations. Final third is devoted to applications of calculus to the various fields of technology. Answers to problems are provided in the appendix.

FUNDAMENTALS OF MECHANICAL INSPECTION, McGraw-Hill, N. Y. 179 pages, illustrations, glossary, index. $1.75.

Covers the how and why of inspection in its field, with a full discussion of the principles and uses of fine tools and precision instruments. The book is directed primarily at trainees and junior inspectors.

AIRLINE TRANSPORT PILOT RATING, by Charles A. and Allan C. Zweng. Pan-American Navigation, Hollywood. 493 pages, illustrations, tables, review questions. $4.

Airmen seeking transport pilot ratings may bone up here. Subjects prepared and illustrated for study include aeronautical meteorology, aircraft instruments, radio aids, radio compass navigation, instrument landing systems, and Civil Air Regulations, the latter covering airport traffic control, control procedures and scheduled air carrier rules. Timely and comprehensive.

MIRACLES AHEAD!, by Norman V. Carlisle and Frank B. Latham. The MacMillan Co., N. Y. 288 pages, index. $2.75.

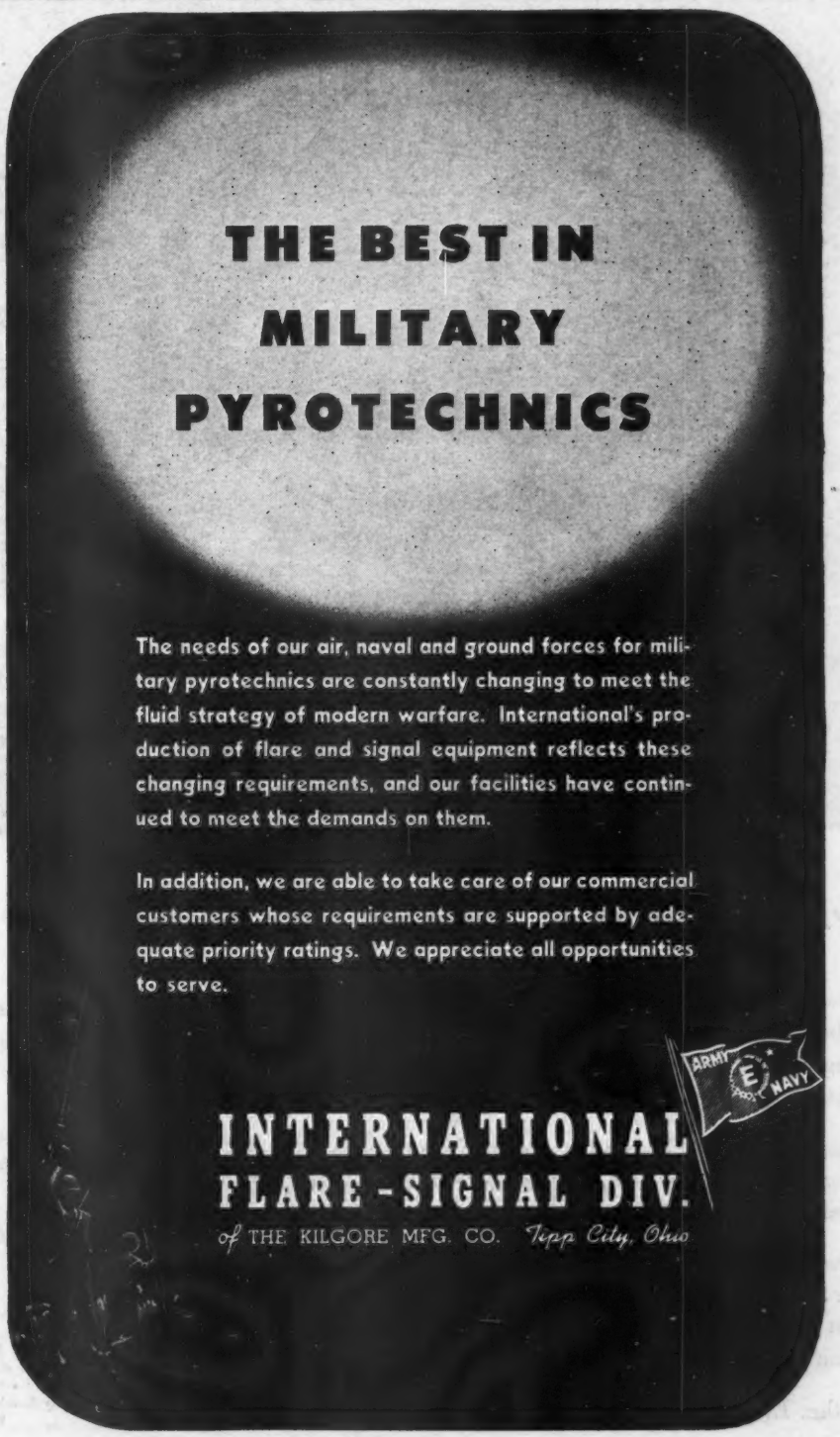
Considers modern science as it applies to everyday improvement in lives, living, and business. A plethora of detail in research and production grouped under general headings such as housing, cars, global transportation, electronics, and synthetics, with overwhelming emphasis on the latter. Frequently rambling, the volume is frequently on the optimistic-vision side.

Future of Aviation Technology

(*Continued from page* 121)

in these cases, as with the airplane, the shipments must be delivered to the carrier and taken away by motor truck. This means that the pick-up and delivery costs may be considered nearly the same.

These cost points, together with those for air and LCL freight, establish a significant curve by means of which we can judge further availability of air cargo business. There is a very important advantage which rail carriers have and will continue to maintain. Rail service comes within convenient distance to over 95 per-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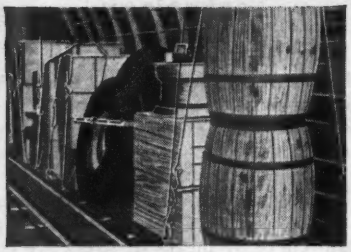
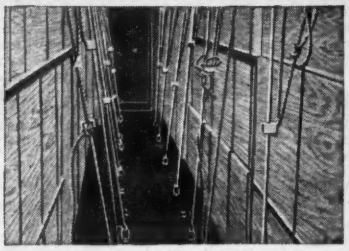
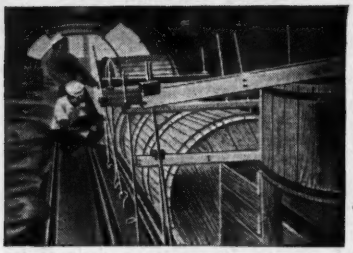


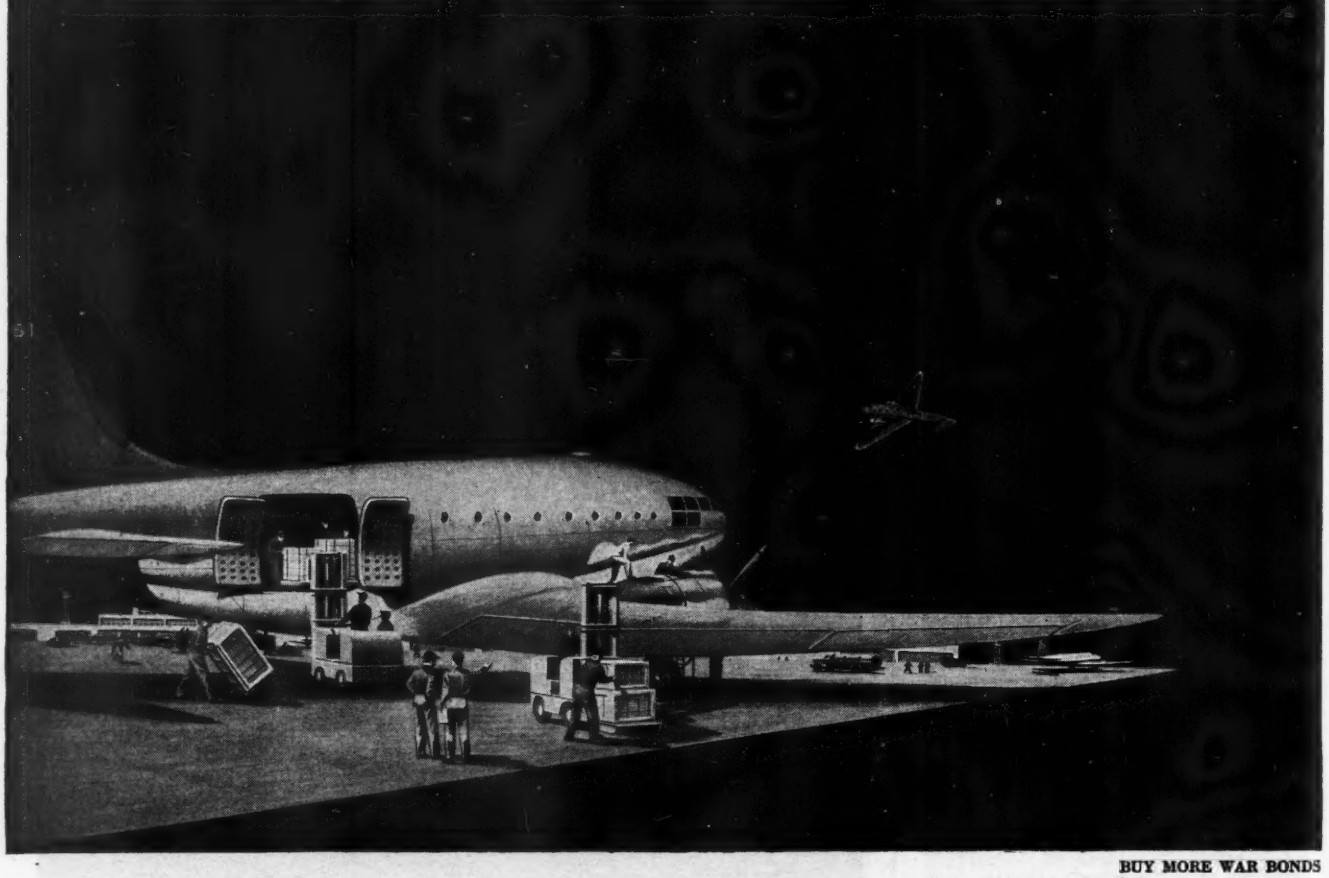
Evans Skyloader rope hooks and tighteners in service on a transport airplane. Note the mixed load and how securely the cargo is tied down.



Full load on a recent assignment. Bulky lashings and weighty knots are eliminated. Notice the even tie-ring pattern in the Evans Skyfloor.



Load is securely held with beams and tie-rods only. Passageway is kept clear and the cargo is readily accessible for speedy, efficient off-loading.



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cent of the population in the United States. The number of all purpose and medium-sized airports will be increased from 280 to more than 3,000, according to present authorization. This construction program will enable air service to reach nearly all of the 3,646 towns of over 2,500 or more persons, but the population having direct access to air transportation will remain far lower than the number served by rail.

On the other hand, off-airline shipments by air showed a more rapid increase than on-airline shipments. But in selecting air transportation, these shippers probably were seeking a time saving advantage, since the cost to them must have been greater than for an all rail shipment. The favorable increase in off-airline cargo business is probably limited, and the total cargo available will no doubt be established at the tonnage where time saving ceases to be the major consideration and beyond which cost is the dominating factor.

The curve of Fig. 3 indicates that air express charges must be drastically reduced if any substantial increase in traffic is to be realized. A reduction from 58.8c. per ton-mile to 16c. should multiply air cargo by 300, considering that the advantage of time saving will remain with the airplane at the same time that the cost is lowered. If a rate of 12½c. per ton-mile were profitable, then a substantial part of the standard railway express business would be taken by the airplane with its superiority in speed, the advantage of wider community coverage remaining with rail express. However, this low rate is not probable within the near future.

Refraining from looking through any rose colored glasses, the possibilities appear to be that airplane technical improvement may permit carrying cargo at charges on the order of 15c. to 20c. per ton-mile. This should produce a traffic between 400,000,000 and 600,000,000 ton-miles in a peacetime year, a not inconsiderable advance over the 2,700,000 ton-miles transported by air in 1940.

Our problem is to see if air transportation costs can be lowered sufficiently to make it attractive to shippers. These possibilities, within known or predictable technical limitations, will be examined in the forthcoming articles of this series.

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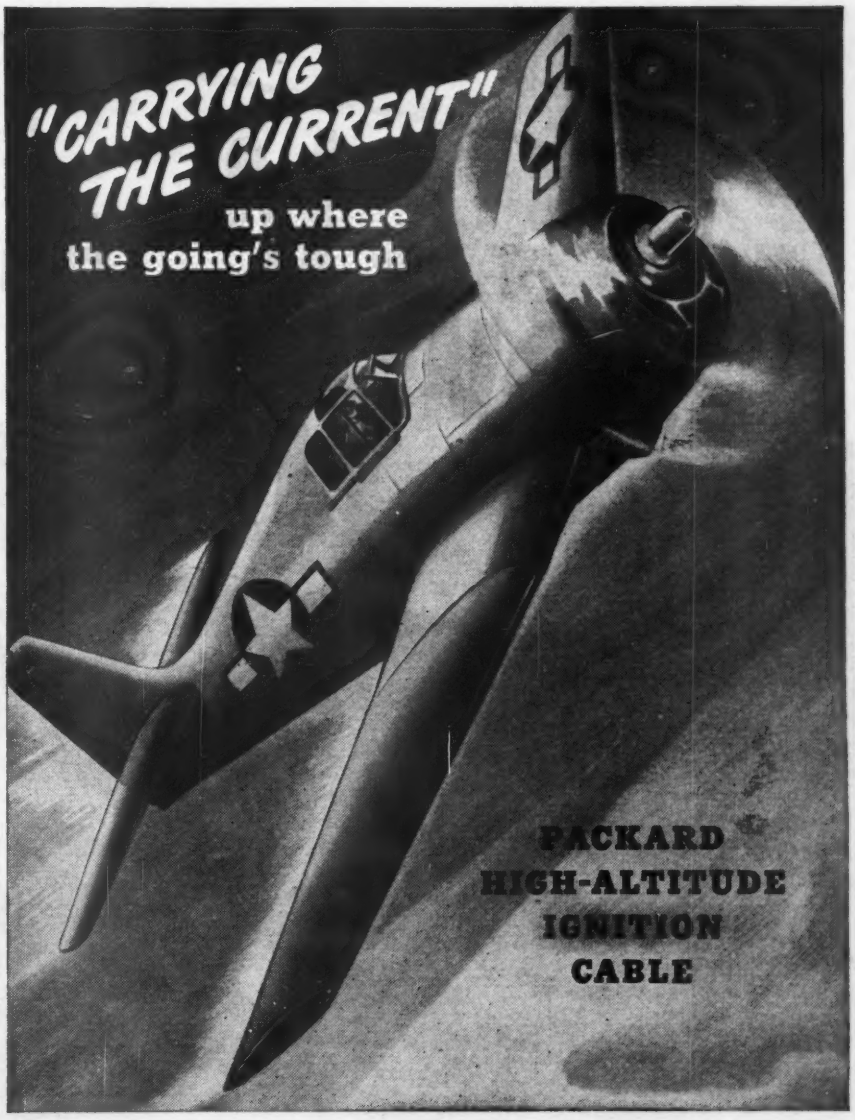
American Air Power Policy

(*Continued from page* 112)

the Post Office initiated the development of air transport through contract airmail under private operation. Regulation and airways development were centered in the Department of Commerce. Technical improvements were encouraged by keen,



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constructive performance and competition. Destructive rate competition was avoided.

Simultaneously, technological development was encouraged through healthy rivalry between the armed services—a great force for progress. Inter-company competition has continued in war, though air craft manufacturers have shared their experience freely through their War Production Councils. They have cooperated in this crisis as effectively as they once competed in normal times.

The benefits of competition were also shared between the armed services and the air transport operators to the overall advancement of both. The fact that American aviation today stands supreme is due largely to the soundness of the fundamental policies evolved by the Morrow Board.

Men have long realized the vital importance to peace and posperity of free communication by land, but it was not until 1889 that the decisive character of over water communication became apparent. Then, Captain A. T. Mahan, in his classic treatise, "The Influence of Sea Power Upon History", proved conclusively that since the dawn of marine transport, victory in war and prosperity in peace have rested with the nation which exercised control of communication by sea.

During the nineteenth century, the world enjoyed unexampled prosperity coupled with spiritual and material progress never before experienced. The combined British and American Sea Power swept piracy from the high seas and guaranteed the right of innocent passage to all who proceeded on their lawful occasions. With this power in the hands of a free people, the play of natural competitive forces accelerated the development of the arts and sciences.

In the twentieth century, this freedom of the seas has been challenged twice in the lifetime of the pioneers of the aircraft industry. In World War I, the Germans challenged with the submarine. The Japanese at first found it expedient to ally themselves with us to obtain German and other Pacific bases. Then, when the Germans tried again with the submarine, (their air force being military), the Japanese challenged with Naval air power. Thus, twice in the first half of this century, the beneficent sea power of free people has been challenged by autocratic powers seeking to dominate and enslave.

We have met this latest challenge by a rapid expansion of land, sea and air power. Today, our air power is supreme: The combined Military and Naval Air Forces of the United States now constitute the world's largest air force. Our aircraft manufacturing establishment is recognized as "the World's No. 1 industrial giant". As to air transport, our private domestic and international systems, already the world's largest and best before the war, have expanded by leaps and bounds.

At strategic points along the airlines of the world, we have built a powerful network of air bases. They are as vital to air power as are Naval bases to sea power. With these stepping stones, the Army and Navy Air Transport Commands have rushed men and materials to distant points in support of far-flung operations. Key men, on the spot, and face to face, have made decisions that insured success in complex operations which would otherwise have failed. The delivery of critical materials at the right place at the right time produced results that would otherwise have been denied. We simply could not have fought this war successfully without air transport.

We have extended air lanes in all directions. Though we look at these now as outward flowing streams, we must not forget that they are channels leading to the very heart of the country. Mahan, discussing the decisive influence of sea power upon our Civil War, and referring to the tightening of the Northern Blockade, said, "The stream that carried the wealth and supported the trade of the Southern states turned against them and admitted their enemies to their hearts."

This sea power comprised five basic elements: the Merchant Marine; strategic bases; the Navy; the shipbuilding industry; and a seafaring tradition. The cost of the Navy was accepted as a proper charge against the cost of water transport —yes, even as an investment in world prosperity.

Similarly, we see air power comprising the same elements: an expanding commercial air transport; strategic air bases; Military and Naval Air Forces; a sound

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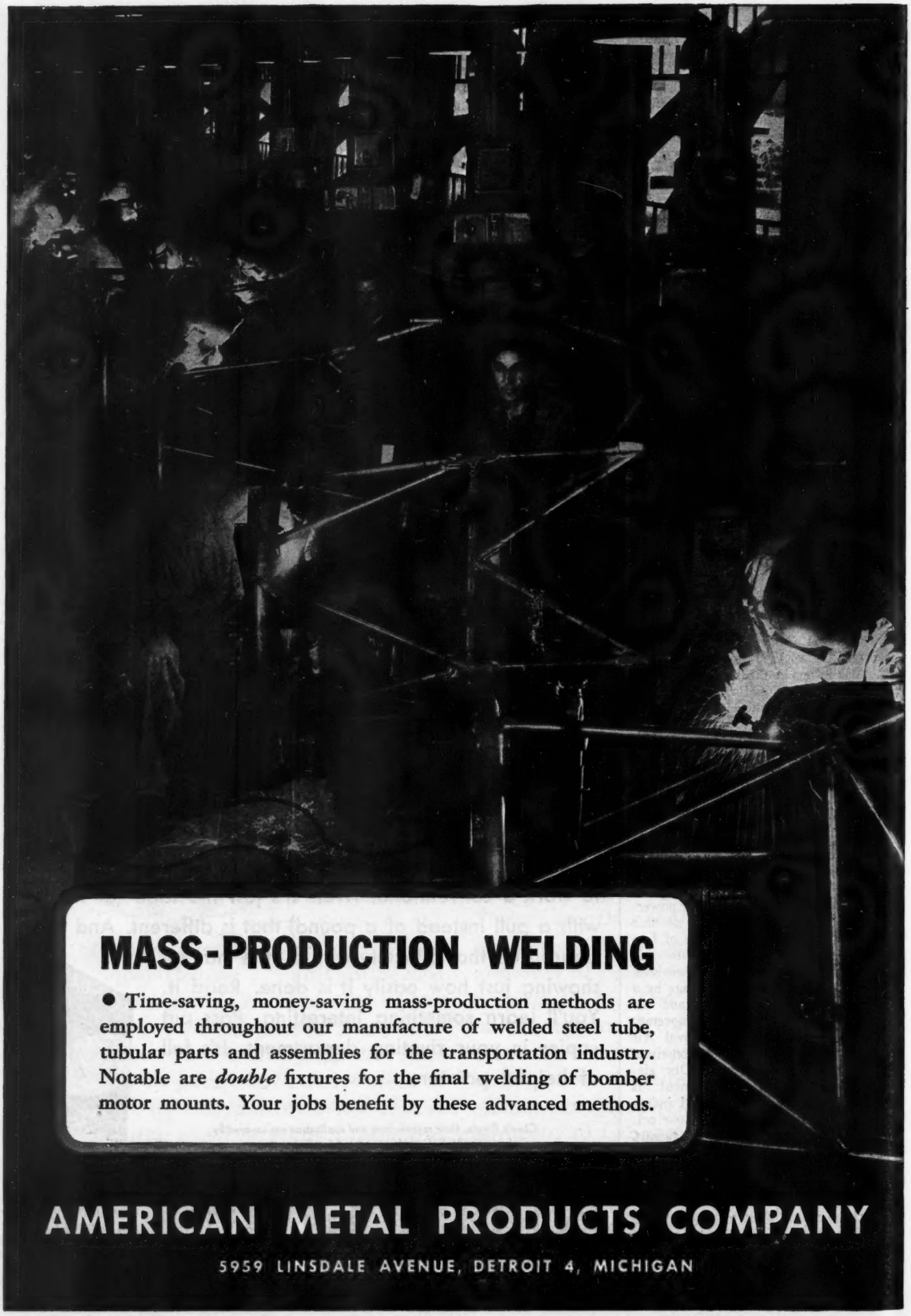
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aircraft manufacturing industry; and an airminded public.

The precise influence upon history of air power is now in the process of determination, but air power's influence upon land and sea communications has been made abundantly clear. Fundamentally, the isolation once enjoyed behind land or sea frontiers is forever gone.

The Current Situation

The aircraft manufacturing industry operates today on a high plateau, having passed successively through three crises. The first crisis involved a shortage of machine tools, the second, a shortage of materials, and the third, a shortage of man-power. Within the latter there is an element of grave danger. Competent management and competent engineering are items whose importance cannot be overstressed. We have brought in management of proven competence from other industries through licensing and subcontracting. We have trained new production management from our own ranks. We have cooperated through the War Production Councils to increase the efficiency of our own management.

But the ability, even the willingness to take responsibility for management is a rare and precious quality. In a highly specialized engineering art like aviation, even men of real aptitude or competence, must acquire experience before they are useful. Even then a special quality is necessary for men who must conceive and create new art.

Ours is the responsibility to provide combat crews with aircraft of advanced design. We must take care that no adversary surprises us with some secret weapon. A technological advantage once lost is not likely to be recovered.

Aviation is a young industry. Most of its personnel is young. Thus, we are certain that the public interest requires the maintenance of the integrity of management and engineering in the aircraft industry. Removal of young engineers from private industry or interruption of a steady flow of them into it is fraught with grave dangers. A design staff once lost is not likely to be restored.

Turning now to production schedules, it is apparent that the very magnitude of the expansion of the aircraft industry makes it especially vulnerable to changes and cutbacks. Since renegotiation of contracts precludes the accumulation of reserves adequate to any contract termination that is not orderly and swift, the Government must accept its responsibilities in termination for all costs, including separation wages, lest important elements of the industry fail to survive. Until the completion of the cycle "war profits" are wholly illusory.

Our situation differs markedly from that of the automobile industry. Every day that passes, more automobiles wear out and the demand for new cars increases. Similarly, every day that passes, automobile companies contribute to the surplus of aircraft and aircraft parts. At termination, automotive companies can reconvert, while aircraft companies must cut back to whatever remains.

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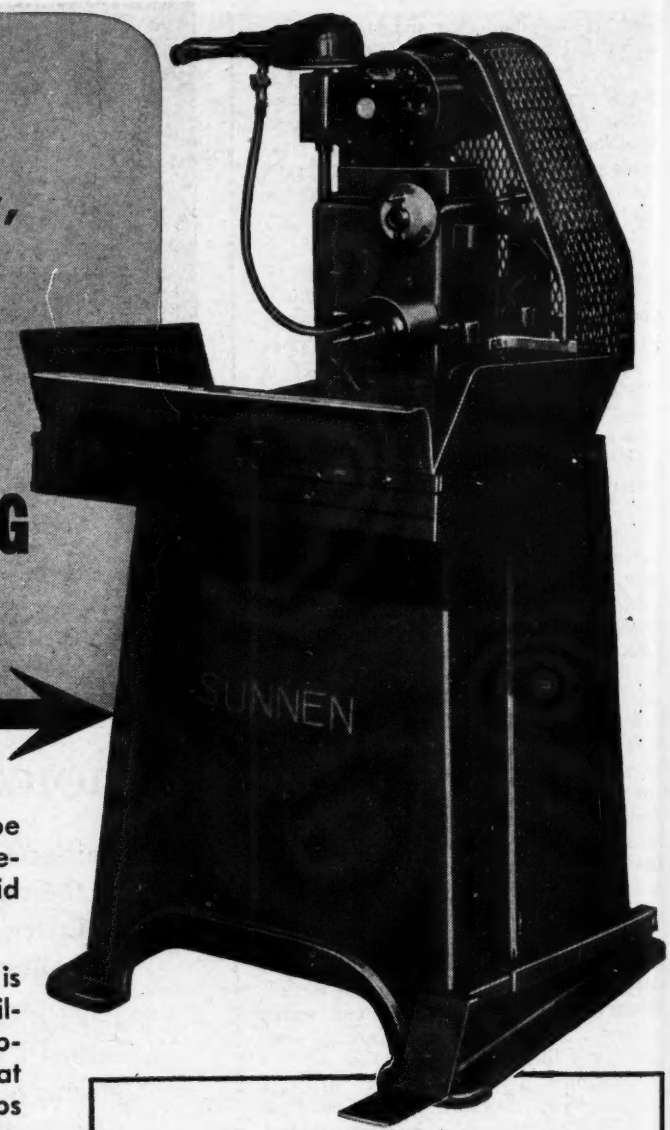

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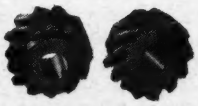

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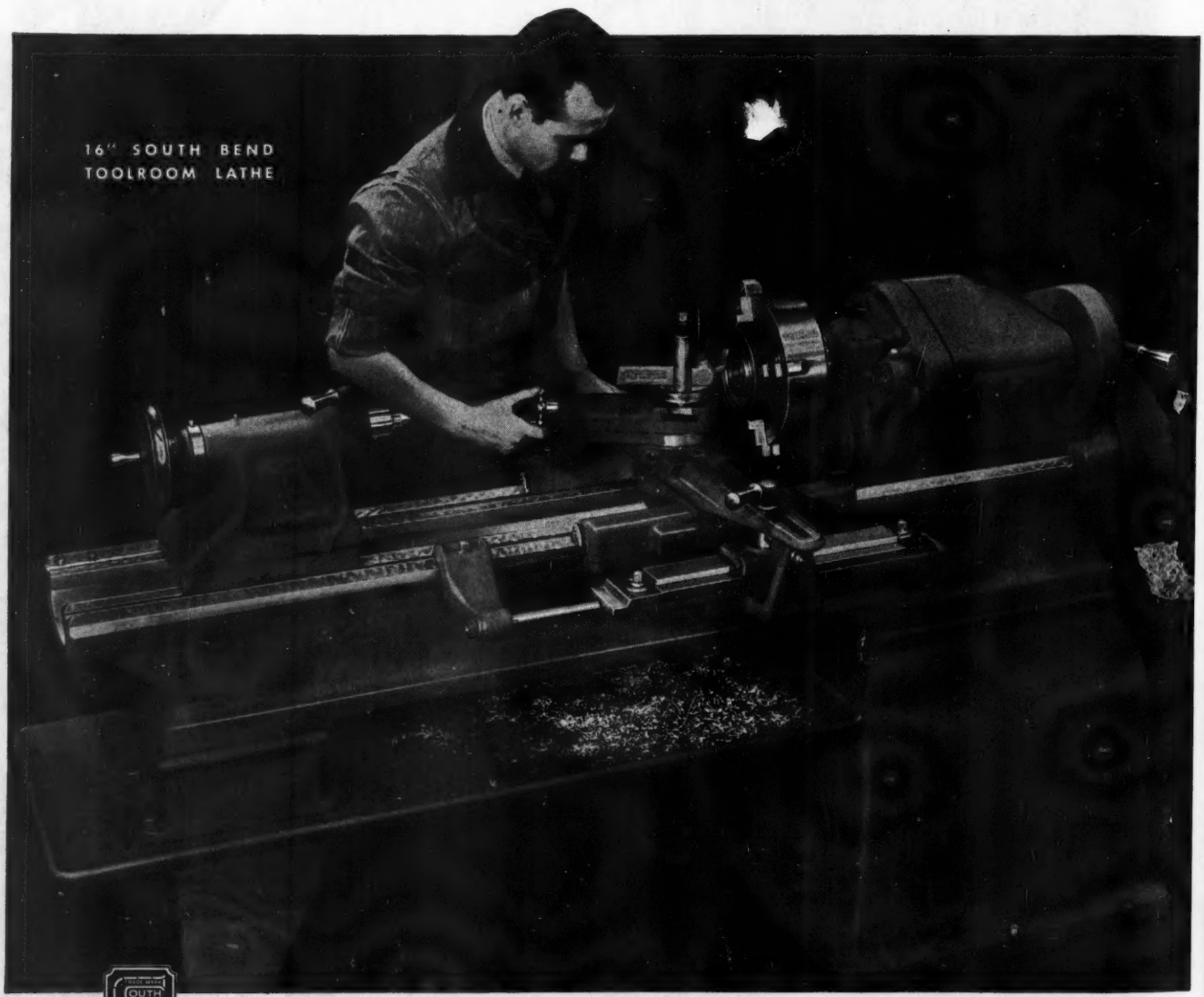

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both date from the beginning of this century, and while 40 odd years later the automotive and aircraft industries are collaborating in the production of aircraft industry designs for the war effort, the two industries are fundamentally different. The automobile has had wide private use. The airplane on the other hand has been used principally in public service. The industry is almost wholly dependent upon government policy.

The problem of surplus war products is thus of peculiar concern to aircraft manufacturers. We note with satisfaction the steps being taken to provide necessary legislation to permit terminating contracts speedily and disposing of war surpluses in an orderly manner. We are impressed with the magnitude of this task and the need for courageous administration and control.

The factor of obsolescene is vitally important in aviation. Equipment is frequently made obsolete by technical improvement long before it has worn out in use. This factor should be given full consideration in controlling production. The flow of material must not run too far ahead of requirements, lest the latest service changes and improvements be not incorporated in combat aircraft.

Thus, the conduct of the war and plans for the future combine to dictate the first step in surplus control. To the fullest extent consistent with meeting every need of the armed services, the tightest rein should be held on current production to avoid unnecessary accumulation of inventories in the hands of suppliers and of finished products and spares in reserve.

Surplus aircraft material should not be viewed as excess inventory to be liquidated like commercial products, but rather in the nature of a reserve. It is public property. It should be administered with broad regard for the public interest. The public interest demands the maintenance of a reasonable level of employment. Dumping surpluses could so unbalance the aircraft industry and the whole national economy that the cost of unemployment compensation, or relief, could quickly exceed any recovery through sale of surplus. War surplus must be considered in the light of other goods expended in the war effort. Good business judgment demands "no dumping."

Surplus aircraft will fall into two categories, those restricted to war purposes and those capable of conversion to commercial uses. The most modern surplus military aircraft should be stored in reserve. This will help employ available excess facilities. Convertible types should be used to promote air transport and private flying.

The rapid rate of obsolescence of aircraft makes timing the key to a sound disposal policy. The sooner surplus planes are made available for commercial purposes the more completely will desirable objectives be achieved. The immediate use commercially of surplus equipment before new improved models are generally available will aid in creating demand for improved equipment.

The vital principle here is that surplus aircraft must not be permitted to destroy the aircraft manufacturing industry. On the contrary they must be so utilized as to nourish it. The public interest requires that the aircraft manufacturing industry operate at the rate necessary to promote the creation of new designs and to facilitate rapid expansion in emergency. This must be accomplished through a continuing, orderly program of competitive procurement for the Army and Navy Air Forces as well as expanding private purchases for domestic and foreign transport. The whole should be supported by direct expenditures with the industry for research and experimental development.

In the matter of government-owned facilities, we are gratified by the steps being taken. Here, too, the controlling principle is the public interest. It must always be kept in mind that until the industry can develop a private market, the government is directly or indirectly its chief customer. It is axiomatic that no seller can compete successfully with his customer and that the private aircraft industry could not survive Government competition.

The record to date clearly shows the wisdom of having depended entirely upon private industry for aircraft production. Industry has met every requirement as to quantity and quality. The stimulus of private competition has produced great benefits. Technology has advanced. Costs have been dramatically reduced. The

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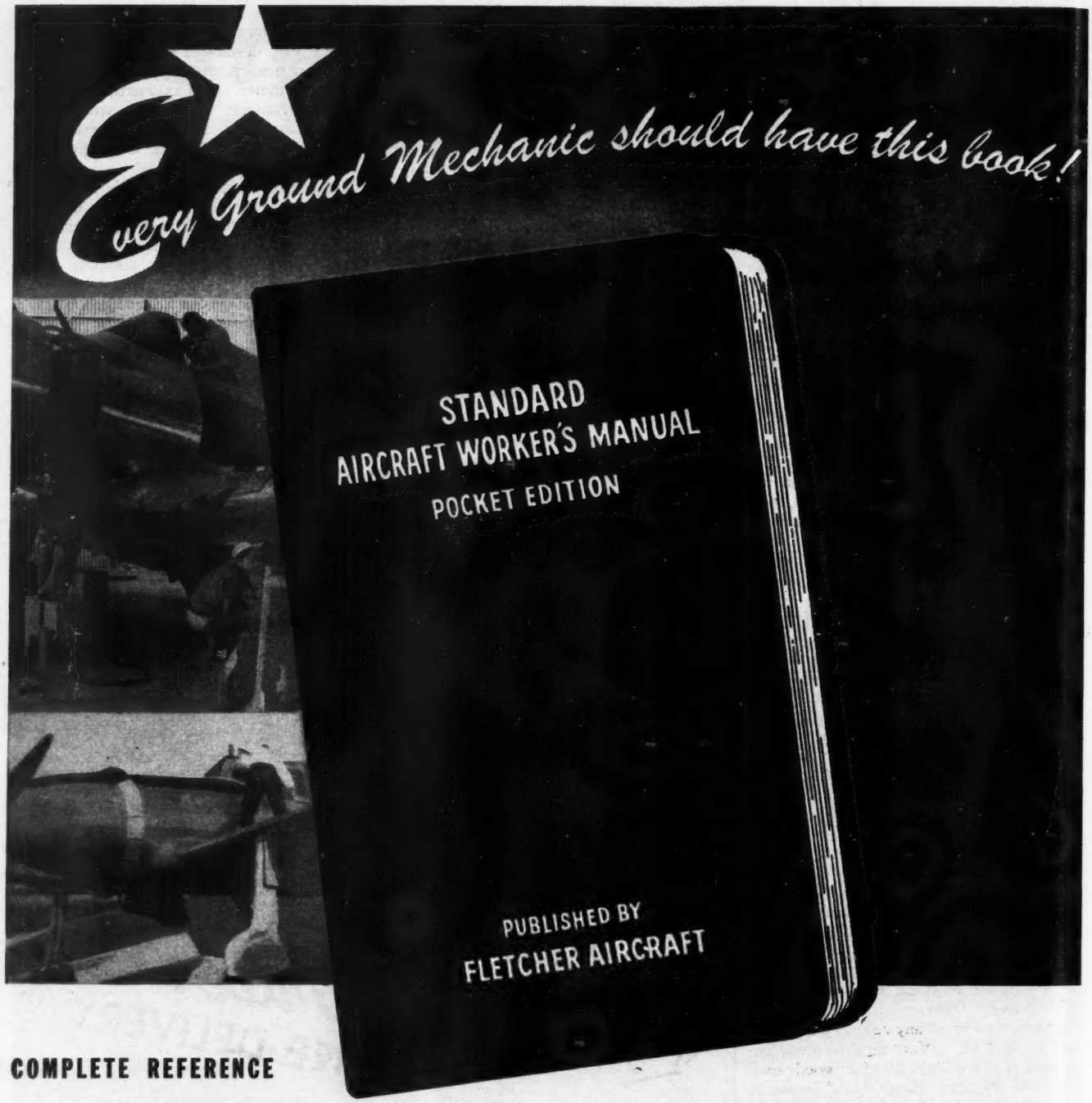

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whole management of aircraft production in this war under the principles enunciated in the Morrow report has been so successful as to clearly indicate the wisdom of continuing these policies. In fact, the whole relationship of government and industry in the aircraft program sets a sound pattern for other lines for the future.

An Estimate of the Future

When the time comes for major cutbacks, the aircraft industry will face problems at least as difficult, if not more difficult, than those incident to expansion. There has been no opportunity to develop other new products. It would seem that the "Minute Men" of this war, who have served the nation best technically and production-wise, should survive. Today, aircraft production represents a substantial proportion of the national economy, and every opportunity should be afforded the industry to maintain itself.

Continued manufacture of unneeded war goods would serve no useful purpose. We would simply be borrowing from future demand. This emphasizes the point made in the reports of the Vinson and Truman committees, that government departments should begin planning now for long-term needs. Military and naval plans could approximate future requirements for several reasonable assumptions, and knowledge of these would assist private companies in their planning.

We also believe that the key lies in the field of air transport. Our domestic airlines are carrying a heavy war load with greatly reduced equipment. It seems unrealistic that at a time when other war activities have greatly expanded their plants, the air lines have been contracted. It would seem in the public interest to step up their operations to a maximum, thus relieving the over-burdened surface transport and speeding the conduct of war business.

International Expansion Needed

The vital importance of international commercial air transport emphasizes the need for its expansion. This should be taken in hand now as an immediate contribution to the war effort and a wise provision for future needs. Expansion of air mail offers a profitable method.

The successful creation of the Air Forces under the War and Navy Departments suggests the need for lodging responsibility for commercial Air Transport in an executive department. This department, in collaboration with the State, War and Navy Departments, should operate under the American Air Power Policy and in support of it. The Office of Assistant Secretary for Air in the Department of Commerce should be reestablished.

As in the case of the air forces, the key to progress in commercial air transport is technological development. Competition is essential in order that economic factors may direct technical progress along sound lines. A prerequisite to the progress of the war effort and to the future of American air transport is the continued development of transport aircraft.

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body technical developments which grew out of air line competition and competitive purchases by the Army and Navy from private manufacturers. These manufacturers reinvested their earnings in improved technology and low cost manufacturing, so that prior to the war, both American commercial and military aircraft dominated foreign markets because of low cost and superior performances.

It is a noteworthy fact that at a time when certain established American industries needed a protective tariff, the self-reliant young American aircraft industry, maintaining a high level of wages and salaries, was able to undersell all foreign competition even though some of this was subsidized.

Our experience leads us to certain conclusions as to the elementary economics of air power. Our people have long been persuaded that expenditures in preparation for war are an out-of-pocket expense, and a burden tending to depress the standards of living. A free people seldom understands that an investment in protection against war may prove far more economical in the long run. Beyond this, money intelligently invested in an air power, adequate to keep the land, air and sea lanes open to commerce, will pay dividends through increased trade and the creation of new wealth. This is the history of each new form of transport.

One example is our own domestic air transport. It has been able to establish itself in direct competition with highly developed forms of surface transport by selling faster travel at competitive rates. It has furnished fast mail at premium rates high enough to return to the Post Office Department, approximately two and one-half times the amounts paid it for transporting the mail. Thus, the Post Office has fostered a valuable public service with a profit to itself.

From the economic point of view, we could credit the air mail profit back against the cost of military and naval aircraft. We might also credit income from export sales. But a strict accounting isn't necessary to prove that providing for the common security is not necessarily a burden upon the people. Done through private industry, it can be an investment. The benefits of judicious purchases to further new technology are obvious. They create new opportunities for private investment, new enterprises and new employment. Expanded Air Transport offers jobs for trained aviation technicians discharged from the Air Forces.

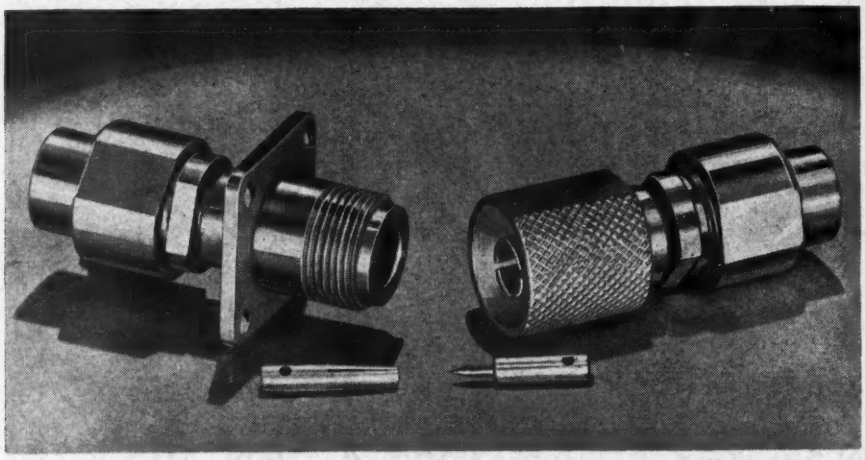
Another example of the profound influence of new forms of transport is the rapid expansion of transcontinental railways after the Civil War. This expansion took place under strong support from the government, and while some evils attended it, the overall result was the opening up of vast new resources. No evils have attended the development of American air transport to date. The possibilities of the future development can scarcely be estimated.

The public character of aviation imposes upon it a dual role. Commercial companies, to advance their private interests and stimulate technical progress, must compete in the realm of operations. At the same time, they must collaborate in the realm of policy to promote the public interest. If any law or interpretation precludes such collaboration, it should be revoked.

Summary

International, domestic and private *Air Transport* offer a source of new wealth and employment. Rapid development is dependent upon improved technology stemming from a strong competitive private *Manufacturing Industry.* A dominant military and naval *Air Force* supported by air bases is a pre-requisite of free communication by land, sea and air. Only an air-minded people can provide that controlling air power which, in the hands of free men, is the hope of lasting peace and prosperity.

Ours is the dominant air power. Ours, too, the responsibility for a sound policy, courageously administed. The American Air Power Policy derives directly from out own experience.



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Flight Stability

(*Continued from page* 141)

types of airplanes will not be too difficult.

Solution of the Biquadratic and Conclusions Derived

Y. J. Liu and Herbert Weiss, both of MIT, have give us an excellent method for

finding the roots of a whole family of stability biquadratics. Any biquadratic equation will contain four roots. In our case, the motion involved implies that for a successful airplane, we must have at least one pair of complex roots in order to satisfy the condition that the oscillatory motion be damped out. Various and numerous are the conclusions which can be drawn from a thorough analysis of the equations and their roots. For the purpose of the investigation of the automatic stability, the most important one is that stability in pitch can be regarded as an independent phenomenon, while stability in roll and yaw cannot be conveniently separated since one influences the other. The order of magnitude of the damping coefficient is for most successful airplanes largest for the pitch axis and smallest for the yaw axis. This fact, coupled with the previous conclusion of inseparability of roll and yaw motions, leads us to anticipate that the difficulties to be encountered in the practical design of automatic pilots will be largest in treating the roll and yaw axis and least in the pitch axis. Experience bears this out.

Another important fact can be recognized which if forgotten will lead to unending complications. The natural return of the airplane to its original trajectory is, as we have seen, of an oscillatory nature. Therefore, if the automatic pilot itself has oscillatory characteristics, great care has to be exercised to avoid resonance conditions. If this fact is not taken into account, instead of enhancing the natural stability by the use of the automatic pilot, we will destroy it. The safest way is to make the actions of the automatic pilot as nearly aperiodic as possible.

Before departing from the extremely abridged discussion of stability, we must mention that stability and maneuverability are incompatible with each other. Obviously, the more stable the airplane, the harder it will be for it to leave its original trajectory. Consequently, if and when such an airplane leaves the trajectory, it will be very difficult for the ship to return to it. Experience proves that very stable airplanes under automatic or manual control are rather hard to manage especially in very disturbed air.

Automatic Pilot—Choice of Detectors

We have now became acquainted, superficially at least, with the general types of motion of the airplane. The problem which confronts us now is to find means to prevent the generation of those natural oscillatory motions. Our first task is to find some means which would react at the first instant when the airplane begins to depart from the chosen trajectory. In the field of instrumentation, we have a very good word for the impulse thus created. It is known as "signal," and this term will be used throughout this paper. There are many indicators which would be made to produce signals showing that the airplane has changed its original position in space or its original velocity. Thus far we have been successful in using only one general type of instrument for this purpose. No others possess the necessary characteristics of signal devices. What are these characteristics?

First, and foremost, we place accuracy. If the signal is inaccurate, the interpretation of the signal by the rest of the apparatus, the eventually generated control impulse will not be a true representation of conditions. Hence, such a signal will be worse than no signal at all, as it may prevent the airplane from returning, after a disturbance, by natural stability to its original trajectory.

A second is the immediate recognition of departures or, as it is expressed in instrumentation, "lagless" response. The motions of a 300 mile per hour airplane are so quick that the signal which recognizes a disturbance even a fraction of a second after it originates, is useless and will in most cases disturb the airplane's natural return to the originally chosen path. The third and also very important feature of the signal is its previously mentioned aperiodicity. A signal which in itself is not "dead beat" and oscillates after the disturbance has been detected and corrected, will superimpose on the airplane's natural motions very undesirable and in some cases dangerous motions.

Among the many possible instruments which can be used as primary signals, only the direct indicators of the angles ψ, θ, ϕ have been found to possess the above-mentioned characteristics.

These instruments are free gyroscopes with the axes placed in such a way that relative motions between the stationary gyro and the airplane produce the angles

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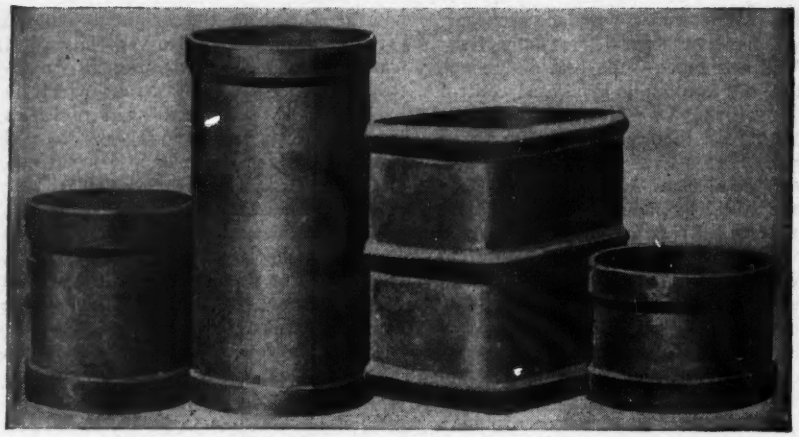

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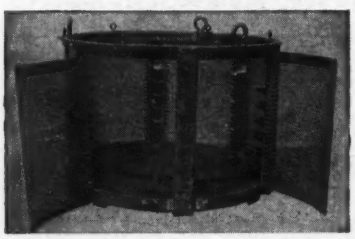

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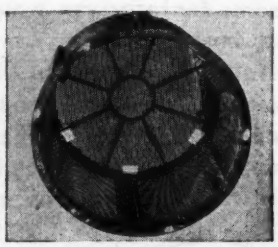

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ψ, θ, ϕ. While the choice of the gyro axes is theoretically immaterial for producing the relative angles, it has been found by practical experience that for detection of angular departures of θ, ϕ i.e., pitch and roll, a gyro with a vertical axis is most conveniently used. For the detection of yaw (angle ψ), a gyro with a horizontal axis produces very good practical results.

Due to phenomena which are peculiar to gyroscopes and which are common engineering knowledge, a direct transmission of those angles from the indicator to the control surfaces is not possible and servo motor systems have to be used. In some cases the signal by itself is of such small magnitude that it cannot conveniently operate the servo motor, and means of amplifying it have to be interposed. The description and analysis of each component would be so lengthy that a separate series of papers would have to be written. The constructional details of the mechanical, electrical, hydraulic and pneumatic devices which form part of many automatic systems have been designed with great ingenuity, and as one can visualize, offer an extremely fertile field to inventors since a great many combinations and variations are possible. The paper by House mentioned in the beginning of this article describes some of the oldest ones, while current trade magazine literature and the *Patent Gazette* both here and in England permit the study of all the intricate details which have to be worked out in order to build a satisfactory automatic pilot. For our purpose we must assume that satisfactory indicators, and transfer, amplifying and servo apparatus exist, and that we know them.

Simple Automatic Pilot

Now, let us take an airplane and see what happens under automatic flight. Assume, for simplicity's sake, that we want to fly in a straight line at an altitude of 2,000 feet. We will make the problem even simpler and concern ourselves at this moment only with the maintenance of the pitch axis parallel to the earth. At a certain instant the airplane is disturbed by an upward gust. The signal which we call α originates and the elevator assumes an angle β in respect to the pitch axis. Obviously, the airplane returns to its original trajectory. One could think, therefore, that the problem is completely solved but, as we shall see immediately, it is at this very moment, when the airplane starts returning, that serious difficulty arises. We have not emphasized, in fact, we have scarcely mentioned, that the airplane, being a rigid body, has inertia, and due to momentum will overshoot the original trajectory by a very considerable amount. At the cross-over point, the signal will reverse and will call for reversed control. The elevator's angle will change signs and the airplane will start a return trip toward our chosen position. The airplane will continue this see-saw motion with perhaps a small decrease in amplitude after each oscillation. What has this automatic pilot done to the airplane? Instead of employing the airplane's natural stability which would have brought the airplane down to its normal trajectory after say two or three oscil-

lations, we deliberately introduced an oscillator and destroyed the natural stability. This fact is emphasized so that we may never forget the effects of inertia and that in any system which comprises a signal device, inertia and servo motors, means have to be provided to establish a proper relation between the signal angle and the control surface angle.

Mechanisms which modify the straight proportional relation between the control surface angle and the angle generated by the signal in such a way as to recognize the effects of inertia, are called "follow-ups."

Disturbances

An airplane gets disturbed by a force. This produces an acceleration; acceleration produces changes in velocity; velocity will produce changes in position or departure from our originally chosen trajectory. If we call α as the angle positioning the airplane about any one of the three axes, (ϕ, ψ, θ); α_0 the angle at the instant of departure; if β is the control surface angle of which the trim value is β_0 again taken for any control, then the following general relation, valid for each axis, can be written:

$$(\beta - \beta_0) = k_1 (\alpha - \alpha_0) + k_2 \frac{d\alpha}{dt} + k_3 \frac{d^2\alpha}{dt^2}$$

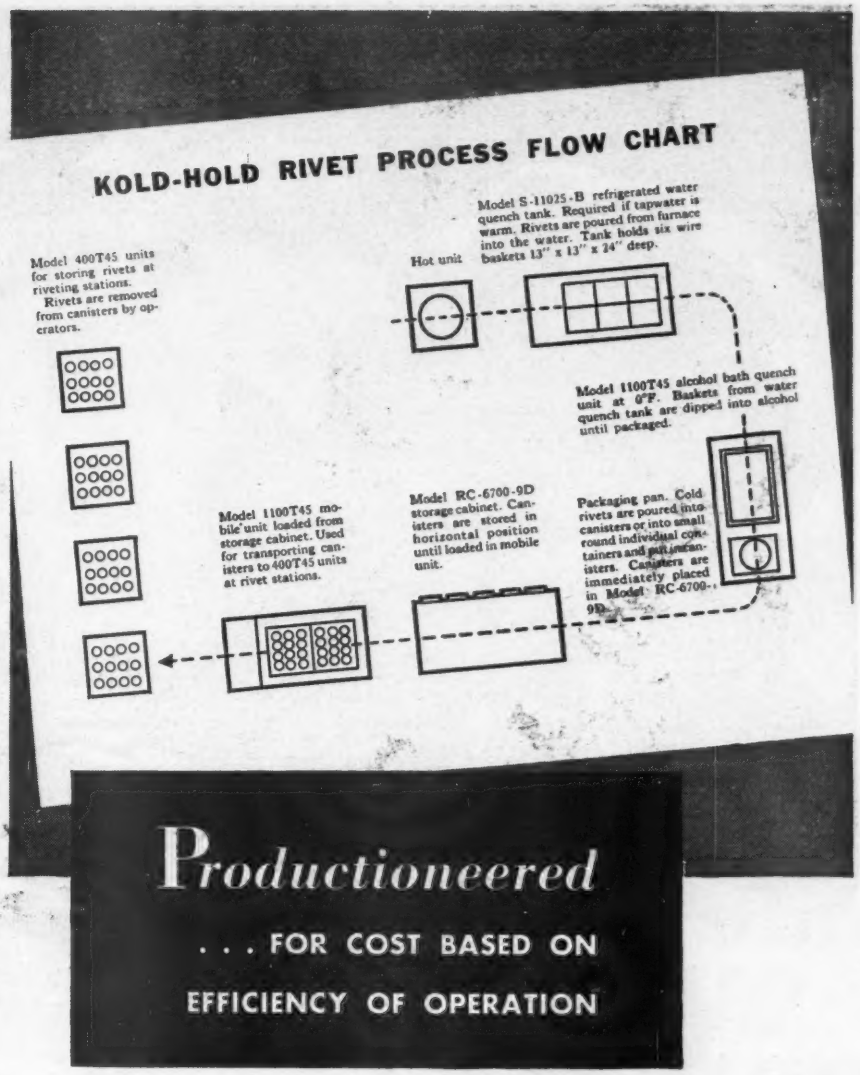
in which k_1, k_2, k_3, are constant.

Follow-Up Operation

Let us go back now to the first experiment in which straight proportionality between the signal angle and the control surface angle was assumed, and substitute for this relation a tie-up as shown by the above more complicated equation. At the instant of the signal generation, β will be large because $\frac{d^2\alpha}{dt^2}$ is large. An instant later β will be somewhat larger since $\frac{d^2\alpha}{dt^2}$, while diminishing, produced a velocity $\frac{d\alpha}{dt}$ and to this sum we have to add the now generated angle α. We are still outside our trajectory, but due to the powerful angle β created an instant ago, we are beginning to return to our chosen path. What is now happening to $\frac{d\alpha}{dt}$?

It has become negative, thereby substantially decreasing the angle β. By the judicious choice of constants, we can arrange it in such a way that the angle β will reverse. We can see that by introducing the velocity and acceleration component, we have found a means of stabilizing the system because a very large control angle is created at the beginning of the disturbance which diminishes rapidly and even reverses as the airplane "coasts" into its original trajectory. k_1, k_2, k_3, are constants and for the time being of unknown value.

Obviously, if we study the stability derivatives and the roots of the biquadratic, we will soon find that a close relation exists between the constants of the automatic pilot and the stability derivatives, and the damping coefficient of the airplane. A very fine interpretation of this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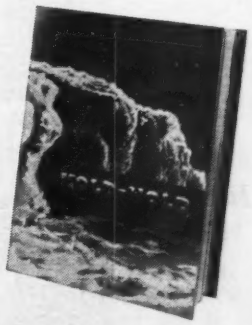

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relation will be found in the paper by Meredith and Smith, published in the Journal of the Royal Aeronautical Society about 1937. Unfortunately, the space limitation prevents us for the time being from following their analysis, but its study is highly recommended as it shows the close kinship between the natural and automatic stability.

It is extremely important at the start of an automatic pilot project to know where the general range of stability derivatives to which the pilot is to be adjusted, will lie.

Otherwise, it may easily happen that a perfectly well-conceived automatic pilot will not fit a group of airplanes because the range of adjustment of the constants k_1, k_2, k_3, will be completely out of range with that of the airplane. Naturally after we have matched the automatic pilot as near as possible to the type of airplane by means of theoretical analysis, we still have to fly the prototype and find experimentally whether the choice of our constants was correct. Experience has shown that if the matching is performed theoretically first, the number of experimental flying hours will be reduced to a minimum and the results obtained superior to those where purely experimental values are obtained for the setting of the nine constants.

Motions of the C. G.

Up to now we have discussed only motions of the airplane about its center of gravity. We neglected to mention the motions of the center of gravity itself. Gyroscopes recognize angles only. While theoretically the stabilization about the center of gravity would be sufficient to return the airplane always to the same trajectory, we must realize that the whole medium is moved by atmospheric disturbances and the airplane will move with it. If we want to stabilize so that the motions of the medium do not affect the position of the center of gravity in space, we have to add another series of signals to our angles detectors. For example, if we want to stabilize the pitch axis in such a way as to insure a constant altitude above sea level or any other reference, we have to add to our "follow-up" equation the expression—

$$K_4 \int_{to}^{t} \left(H - H_0 \right) dt$$

H is altitude. Similarly, we could add a geographical signal to be superimposed on to the yaw axis, thereby forcing the airplane to fly automatically toward a chosen geographical point. A great deal of variation is possible and the choice of supplementary signals offers a very fertile field for experimenters. Various specifications can be met and the choice of signals will depend on them and on the accuracy required further on the purely mechanical complications which may occur in performing such additions.

We have not touched on the subject of imposing our own will on to the automatic pilot, but it may be said briefly that any automatic pilot must have provisions by which the airman can perform all kinds of maneuvers such as spiral down, climb, turn, etc. In this era of "blind" landing, and "blind" take-offs, it

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is desirable to have such attachments which would enable the automatic pilot to translate signals coming from landing beams into automatic impulses making the craft descend a predetermined landing path. It would take many hours to explain the versatility of the automatic pilot and the very ingenious mechanisms which have been developed for this purpose.

Conclusion

We have sketched the difficult path which led airplane designers toward the understanding of fundamentals of dynamic stability. An equally thorny road full of obstacles has been conquered by the instrument engineer who succeeded against such odds as space and weight limitations, lack of power, etc., to produce a very creditable substitute for the human pilot. In many instances the automatic pilot is much superior to the airman and especially now when distances to be flown are great and flights have to be executed at 30,000 ft. and above. The automatic pilot never tires. In many instances the airplane engineering field and the instrument engineering fraternity have worked independently on the problem which concerns both branches directly. Pooling the knowledge of dynamic stability with the knowledge of instrument design for the general betterment of aeronautics is essential, and if this paper has acquainted airplane engineers with the instrument problem and vice versa, if it has shown the great wisdom in undertaking a mathematical analysis of the problems involved, it has accomplished its purpose.

Rivet Machine

(*Continued from page* 153)

different rivet diameters. The narrowest slots are at the upper end next to the hopper, and each succeeding slot increases in size toward the lower end where rivets too large to enter the slots will continue to the end of the trough and enter a receiving tray.

Baffle plate: A plate extends down each side of the trough across the ends of the comb teeth and is positioned just high enough above the top surface of the teeth to permit the head of a rivet which is swinging in a slot to slide under and enter the receiving bin but not enough for the diameter of the rivet head to pass through. Thus, the rivets which are in slots slide out freely, since only the flat *thickness* of the head has to clear, but those still rolling on the surface of the comb plates are barred by the diameter of their heads. Small vertical pins are staggered across the area of the comb plates to reverse the roll of the rivets as they pass, and short extension fins are provided on the sides of each comb plate to further interrupt the downward travel of the rivets and thus aid in the sorting operation.

The 50,000-rivet-per-hour capacity of this machine is equivalent to from 8 to 12 lb. of rivets—meaning a decided saving when operating every working day of the year.

Fly Yourself

(*Continued from page* 184)

out that it has not proved possible to use regular automobile credit forms, customer rental lease agreements, or courtesy cards; the problems involved are too different. About the only connection now appearing possible between fly yourself and drive-yourself services is that the latter's downtown offices might be used as selling agents.

Even if money is available to buy and insure enough planes, and credit can be established for a sufficient number of customers, there are still additional problems to be solved.

The most important one is this: It is practically impossible to make a profit on Fly-Ur-Self operations alone. They must be tied in with other activities. In fact, it is the writer's opinion that the Fly-Ur-Self set-up must be linked with four other operations: Aircraft sales, overhaul and maintenance service, sales of accessories and parts, and charter work. Aircraft sales include, of course, both new and used equipment in which the rental aircraft themselves are always on the market. Naturally, a Fly-Ur-Self service would provide some work for maintenance personnel and equipment, but both could be kept going more nearly to capacity by taking in outside work.

Whipping the foregoing problems still doesn't guarantee opening the pearly gates of profit, for a single-handed Fly-Ur-Self operation must of necessity remain of limited scope. The obvious answer would be to make direct-contract tie-ups or working agreements with others in the same field. This, in turn, means finding the right men with whom to do business.

It Takes Time and Money

This is no insurmountable problem, for such men are available throughout the country in sufficient numbers; it's simply a time and money-consuming job to find them. Such men must be operators possessing three qualifications: Integrity, ability, and (if this can be called a personal qualification) sound financial standing, with the three running in that order or importance.

Making connections with other operators to form a network of Fly-Ur-Self bases naturally brings up two questions: First, how many would it take?; and, second, how much would it cost each of the operators?

It is my belief that the United States could be well covered with 100 bases, a number considered sufficient so that the oft-talked of rent-it-here-leave-it-there service could be offered. If such a network were to be a cooperative venture, it is believed these 100 operators would have to invest at least $10,000,000, or an average of $100,000 each, in addition to setting up uniform accounting, maintenance, and other service facilities. The phrase "at least," as applied to the outlay of money, is used advisedly, for it is patent that different localities will require different investments, just as they will produce different returns. The metropolitan New York City area, for instance, would require an investment of at least $500,000 if the job were to be done properly.

Suppose, it may well be asked, it appears desirable or looks like a good bet to start from scratch and set up a nation-wide service on a corporation basis—then how much money will it take? Again, on the basis of experience (plus considerable "3 to 5 A.M. planning") it would seem the $10,000,000 figure would be the bare minimum.

This would assume at least $5,000,000 going for equipment consisting of 1,000 planes of, perhaps, no more than two types —two-and four-place. If these planes were all ordered from one manufacturer it is felt possible the craft could be bought within the $5,000,000 budget.

To date, however, few manufacturers have made serious inquiries about the types of equipment that might be desirable, a situation which is understandable in view of the fact they are all thoroughly occupied on warplane production. But the time is coming when they will be seeking such outlets for their production lines, because there is every chance that a national Fly-Ur-Self service—cooperative or corporate—can become a vital factor in the personal plane market built up in the coming peace.

WHAT'S THE USE OF ADVERTISING RIVETS

if we can't supply them?

That's a fair question to ask if, as you may correctly assume, we are now producing 100% for Uncle Sam.

If, however, you who read this are like hundreds of other American manufacturers, you are at this time planning for post-war production requiring rivets, screws or other fastening devices.

And some morning, when the radio blazons forth the news of the United Nations final victory, you will hurry to the office, get those plans off the ice and start the wheels in motion for that "era of plenty" ahead.

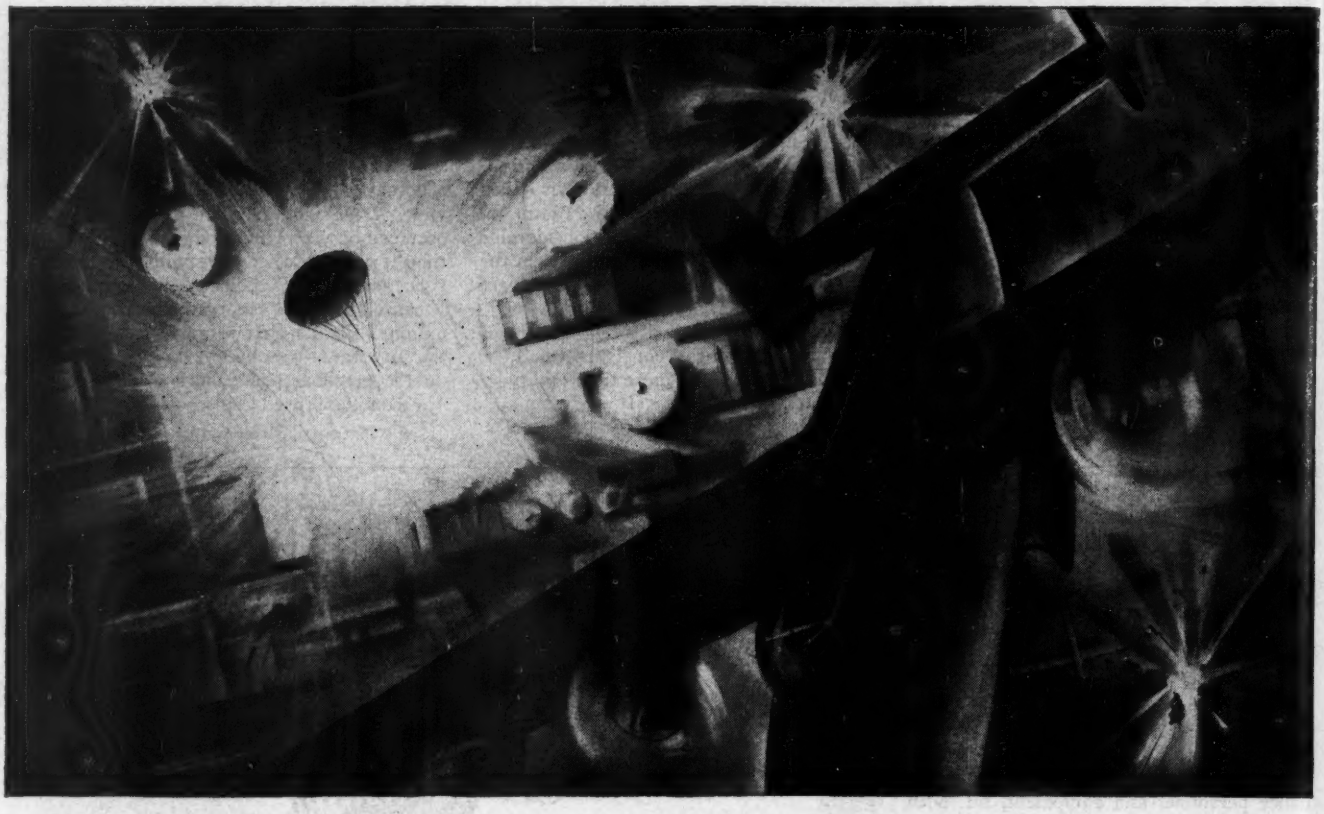
If rivets fit into your product, why not arrange now for your future source of supply? We would like to tell you more about our ability to satisfy your post-war needs. Aircraft Rivet Chart on application. Write us.

★ ★ ★ ★ ★

The MILFORD RIVET & MACHINE CO.

Post Road, Milford, Connecticut

GENERAL RIVET & MACHINE DIVISION, ELYRIA, OHIO



Planting A Victory Garden . . . *by Candle-Light*

A STRANGE and fearful candle-light brightens the streets of this Axis town tonight. A moment ago, it lay safely hidden under cover of a moonless blackout.

But, it was on tonight's schedule of time-table bombing and as "Libs" and "Forts" come in for the "kill", this night-time enemy target is brought into sharp relief by the brilliance of McAleer military pyrotechnics.

In that revealing glare the refinery's oil tanks stand out like giant mushrooms in a meadow—but not for long. Caught in the cross-hairs of a bombsight, they disappear in thick black smoke. A power station crumbles under a well planted "stick". Factories and warehouses belch flame that reaches fiery fingers into the heavens.

It's Victory Garden planting of a different sort. Seeds of retribution from which will come fruits of Victory!

Making military pyrotechnics is but one of the important war production tasks assigned to McAleer. There are other For-Victory products extending into the fields of military aeronautics and hydraulics as well.

ON THE HOME FRONT we fight the war too . . . furnishing *quality-controlled* finishing materials and methods which contribute more to the war effort. If increased finishing efficiency on metal, plastic or wood can help YOUR war effort . . . our advisory facilities are at your service.

McAleer MANUFACTURING CO.

Manufacturers of Quality-Controlled Finishing Materials, Military Aircraft Sub-assemblies and Pyrotechnics . . .

ROCHESTER, MICHIGAN